Chapter 2

The Many Facets of Skills

Major changes in the Nation's economic environment have fostered an increasing need for information on both the supply of skills and the demand for them. Over the past few decades, the country's economy has moved from an era of industrial production to the "information age." New industries have been created and older industries have declined dramatically. Success in this new economy depends primarily on a workforce that can adapt to constant change and adopt the new technologies to make production more efficient.

To make informed decisions, different groups look at skills in the labor market in different ways. Policy makers, for example, want to know if the current labor force is highly skilled and versatile enough to sustain economic growth. Employers will want to evaluate the skills of their workers to identify needs for training or new hires. Employers and compensation specialists want information that will help them determine the wages they must offer to be able to hire workers who have the skills that they require. Individuals want to know what specific skills they will need to acquire to obtain their first job, to qualify for and succeed in their intended career, to gain a promotion, or to continue functioning effectively in their current job in a changing environment.

Employers are increasing their demand for workers with specialized skills. Although education has always been valued, employers are seeking to hire highly trained workers and are providing training on both basic skills and new techniques to their current workforce. As a result, the pay gap between highly skilled workers and less trained workers continues to grow.

At the same time, many new and old service establishments do not require specialized skills. Instead, they depend on convenience, choice, quality, and price to satisfy their customers. Workers in many of these jobs do not need a college education or advanced training.

Using a variety of historical BLS data and some new BLS measures, this chapter explores the following topics:

- Alternative dimensions of skill
- Changes in the economic environment and their effects on the skill composition of the labor force
- Broad measures of change in the education and work experience of the labor force

In This Chapter—

	Page
Defining skills	38
The Economic environment	38
Broad measures of change in education and work experience	41
Skill change and shifts in occupations and industries	45
Sources of skill change	45
Overall skill change	46
Skill change resulting from shifts in industrial composition	47
Skill change resulting from occupational shifts within detailed industries	47
Summary	48
Analysis of trends in education and training requirements	49
Overall changes in occupational skill across industry sectors	49
Occupational shifts by educational requirements	52
Quality of job growth	54
What do these trends really tell us?	55
Relationship between earnings and skill	55
Occupational shortages	60
Conclusion	63

- Changes in average skill levels resulting from shifts in employment by industry and occupation
- Trends in occupational education and training requirements
- Relationship between skills and earnings
- Occupational shortages

Defining Skills

There are different dimensions to the concept of skill. In a labor market context, skill refers both to the abilities, or human capital, of *workers,* as well as to the specific requirements of individual *jobs (*or jobs classified into the same occupation category). The real distinction in looking at the skill of workers, as compared to the skill requirements of occupations, is that workers can be viewed by their potential. Skills, abilities, and knowledge that workers possess indicate what they can do. Skills are learned over time, through instruction and practice. A young labor market entrant with little schooling, by definition, is unskilled. A worker with some education but no practical work experience becomes more skilled through practice, on-the-job training, and continuing education. Therefore, both education and accumulated work experience contribute to the skill with which a worker performs a job and the wage rate that he or she can command, so long as the prior schooling and work experience are relevant to the current job.

The skills people bring to the labor market have changed over time. In addition, changes in average skill levels in the overall economy can result from changes in: 1) The industrial composition of employment, 2) the occupational composition of employment, and 3) changes over time in the average skill requirements of given occupations. That is, employment growth (or decline) in certain industries and shifts over time in the types of workers needed within a given industry alter the number of workers required in certain occupations.

Occupational requirements can also change over time, but to track these changes requires detailed information. Occupations are classified based on their required tasks and duties, which can be further defined in terms of the skills needed to perform those tasks. Workers also must possess certain skills and knowledge in order to qualify for entry into different occupations. The Department of Labor has developed the Occupational Information Network, or O*NET (see box), to provide this type of information.

Among economists, the concepts of skill differentials and wage rate differentials are closely related. The value of a worker's time depends on the usefulness of his or her skills in the production process. It is assumed that employers will not pay employees more than the value that they can produce, and that employees will not work for less than the wage rate they could earn elsewhere. Thus, wages are often used as an operational proxy for skill level.

This chapter uses several different measures to examine changes in the skills of the labor force and the skill requirements of occupations. The definitions of these various measures will be explained as they appear in the course of the analysis.

The Economic Environment

The economic environment provides the context for our discussion of work skills of the labor force. Since 1983, the United States has enjoyed two long periods of sustained economic growth, interrupted by a single and relatively mild recession. The current economic expansion has lasted

Occupational Information Network—O*NET

The Department of Labor's Employment and Training Administration released the O*NET 98 database and viewer to the public in 1998, along with a user's guide and data dictionary. O*NET is a comprehensive database of occupational requirements, including information on required knowledge, skills, tasks, and machines, tools, and equipment, as well as data on worker requirements and characteristics, using a common language to define and describe the various elements. The flexible design and electronic database format of O*NET are intended for rapid capture of changing job requirements. These technological enhancements will remedy the drawbacks of the precursor to O*NET, the static *Dictionary of Occupational Titles*, which first came into use in the late 1930s and was updated through new editions roughly every 10 to 15 years.

longer than any other in the post-war period. Per capita increases in stocks of "broad capital," that is, stocks of both physical and human capital, have resulted in increased worker productivity and increased output per person.[1]

Several economic forces have underlying effects on the skill-composition of the workforce. Shifts in the demand for skill stem from technological change, and increased "globalization" of production. At the same time, long-run changes in education, training, and work experience, as well as long-run shifts in the sex and age composition of the labor force and the impact of immigration have redefined the skills that workers bring to the labor force.

Technological change. New technologies have reshaped the skill needs of today's labor force, either in the restructuring of the requirements of individual jobs or the distribution of employment across jobs. The changing face of the labor force did not occur overnight; in many establishments, both old and new technologies are used simultaneously. This effect of technological development is not uniform for all jobs. For some, the required skill level has increased, for others it is reduced, and for yet others it has remained unchanged.

The content of a given job may have changed through technological innovation, although the job title remains unchanged. This is highlighted below in the description of drafters in the 1966-67 and 1998-99 editions of the *Occupational Outlook Handbook.*

Drafters today still do the same work as they did 30 years ago; they just use additional, more complex skills to perform their tasks.

The widespread use of microprocessors has led to a restructuring of factory and office jobs throughout the economy. Several work tasks, previously completed by unskilled and low-skilled

Drafters

Characteristic	1966-67 duties	1998-99 duties
Nature of work	Draws detailed working plans from the ideas, rough sketches, specifications, and calculations of engineers, architects, and designers. Might also calculate the strength, reliability, and cost of materials and plans.	Prepares technical drawings and plans.
Tools	Uses instruments such as compasses, dividers, protractors, and triangles, as well as machines that combine the functions of several devices. May also use engineering handbooks and tables to assist in solving technical problems.	Uses technical handbooks, tables, calculators, and computers. Most drafters now use computer-aided drafting (CAD) systems to prepare drawings.
Recommended education or training	High school or post-high school courses in mathematics and physical sciences, as well as in mechanical drawing and drafting. The study of shop practices and shop skills are also helpful.	Postsecondary training including a solid background in computer-aided drafting and design techniques as well as communication and problem-solving skills.
Qualifications for success	Ability to visualize objects in three dimensions and to do freehand drawing.	Well-developed drafting and mechanical drawing skills, a knowledge of standards, mathematics, science, and engineering technology.

workers, now may be handled through automated machines. With the elimination of repetitive, routine tasks, the remaining workers are called upon to perform tasks of increased complexity. The skills requirements of some jobs have increased (as demonstrated in the drafter example above), whereas the level of skill required for some low skilled jobs has either been reduced or the job eliminated entirely. For example, sales clerks may no longer need to key in the price of an item, but can either scan the product or point to a picture of the item.

In addition to restructuring the requirements of specific jobs, firms also can change their staffing patterns or the mix of occupations they employ over time. In the cigarette manufacturing industry, for example, between 1989 and 1995, the share of production workers decreased by 12 percentage points (from 66 percent to 54 percent), while nonproduction workers increased in share by 14 percentage points (from 32 percent to 46 percent). Even though overall employment declined in this industry between 1989 and 1995, nonproduction workers increased numerically as well as in share, partially offsetting the overall decline in the number of production workers.[2]

According to one BLS study, a large part of the modification of the content of jobs can be attributed to technological change. "Although job titles frequently remain the same while innovation is taking place, over time, employers have less demand for manual dexterity, physical strength for materials handling, and for traditional craftsmanship. In the printing industry, for example, electronic composition methods have replaced long-standing craft skills, and employment of compositors and typesetters has declined sharply."[3]

Globalization of production. Shifts in the industrial composition and organization of production constantly cause changes in the skill mix of the U.S. labor force. During the first half of this century, many manufacturing industries shifted away from small artisan shops toward the use of assembly-line techniques. These technological changes may have contributed to general declines in wage rate differentials between skilled and unskilled U.S. workers over the period 1930-50.[4] More recently, U.S. multinational corporations have relocated a significant portion of their low-skilled production sites to foreign countries where wage rates for unskilled workers are even lower. Moving more jobs abroad decreases the demand for low-skilled labor within the United States, while increasing the demand for higher-skilled workers who coordinate or oversee foreign production.[5]

Export-oriented manufacturing plants account for a significant portion of the increasing earnings differential between more and less skilled workers in manufacturing.[6] Technological improvements in computer efficiency and telecommunications have clearly lowered the costs to U.S. multinational corporations of production abroad, as well as the costs to foreign multinationals of production within the United States.[7] Indeed, a number of studies have found that rising capital per worker and information technology in particular leads to an upgrading of the workforce toward better educated workers and white collar jobs.[8] Thus, technological change and foreign outsourcing may well be the complementary, not conflicting, forces behind increases in skill differentials within the United States.[9]

Education. The population of the United States is large and diverse. We are a Nation of immigrants for whom education has served both as a means of social integration and as a source of literacy and numerical skills.[11] Education is widely viewed as an investment that will provide prospective workers with the skills required to obtain good jobs and to earn high wages. The average schooling levels of men and women in the workforce have been approximately equal, increasing steadily, since the 1930s.[12] But children enter U.S. educational systems from a variety of backgrounds, and the income and schooling levels of their parents are known to have an important influence on their school performance.[13] Therefore, it is perhaps not surprising that, compared to other large industrialized countries, the U.S. workforce includes a larger percentage of adults with relatively low verbal and quantitative skills, as well as a larger percentage of adults with relatively high skills.[14]

Training. While schooling itself is an important source of skills, workers devote considerable time to training as well. Roughly 70 percent of establishments report that they provide formal training on the job, and roughly 95 percent of large establishments provide some worker training. Except for the construction industry, there appears to be little difference in training rates by industry.[15] Among young new hires, nearly a third of time at work is spent in formal and informal on-the-job training.[16] There is some evidence that union members are more likely to receive com-

pany training, as well as training from business institutes and school sources, than comparable non-union workers. Therefore, declines in union membership rates may reduce the likelihood that blue-collar workers will receive structured training on the job.[17]

Work experience. The accumulation of relevant work experience is a prerequisite for most higher-skilled jobs. The amount of work experience needed before an employee is fully competent or reaches journeyman status differs by occupation, establishment, and industry. Given the investment made in acquiring skills through work experience, it is not surprising that during periods of economic downturns, employers will lay off less senior workers first. Thus, skills and employment stability both increase with tenure.[18]

Sex. During the past 50 years, many women have entered the labor market. As their numbers have increased, women are taking less time off for child rearing activities. This stronger attachment to the labor force provides women with greater incentives to specialize in job-related fields while in school, and increases the likelihood that they will receive the on-the-job training required for advancement to higher-level jobs.

Age. The current labor force is dominated by a large cohort of well-trained middle age workers. These highly educated baby-boomers have achieved senior positions at work, and may be diminishing the employment prospects of younger, less-skilled workers. As a result, some younger workers may well have fewer opportunities for growth and training.[19] However, the aging of the U.S. population, in combination with increasing female labor force participation rates, is expected to generate significant employment growth in occupations devoted to elder care services in the near future.

Immigration. Estimates suggest that an influx of unskilled immigrants may explain between one-half and one-fourth of the increase in the earnings differential between workers with a high school degree and workers with less schooling over the period 1980-95. [20] An increased inflow of low-skilled immigrants to the United States may decrease both the probability of employment and the wage rate received by low-skilled residents, with whom they compete.[21]

Broad Measures of Change in Education and Work Experience

Concurrent with widespread changes in the distribution of jobs and the complexity of work, over the last 30 years the workforce has evolved in its composition and its preparation for the changing job market. Among the most dramatic changes, the labor force participation of women has risen sharply from 41.6 percent in 1968 to 59.8 percent in 1998, and the share of all jobs held by women increased from 37.1 percent to 46.4 percent of the labor force.[22] The many children born between 1946 and 1962, sometimes known as the baby boom generation, grew up, entered the workforce, and now have accumulated a significant amount of work experience. Overlaying these changes has been a steady increase in educational attainment as the next generation is more educated than the one before.

Changes in the demographic characteristics of the population, as well as the other long-run changes in the economic environment described in the previous section, mean that the skills of an average worker in 1968 are very different from those of an average worker in 1998. The distribution of workers' skills changes slowly. At each point in time, there is a variety of skills among workers in different occupations, and within different levels of each occupation. Acquisition of these skills depends on each person's abilities and opportunities. Persons with relatively more ability acquire skills more quickly and efficiently than persons with less ability. Persons with relatively more resources are more able to invest the time and money required to achieve a given set of skills.

There are a variety of metrics for measuring worker skills, but few that are available for all workers and that provide a consistent picture over time. But if skills are learned over time, through instruction and practice, then years of school completed and years of accumulated actual work experience are one obvious set of indexes of workers' skills.

Hours-weighted averages of years of school completed by men and women have increased, and converged, during the post-World War II period. As shown in text table 1, the average educational attainment of men and women has risen from about 10 years in 1948 to more than 13 years today. The declining share of hours worked by those without a high school diploma is clear. In 1948, men without a diploma accounted for more than 60 percent of all hours worked by men employed in the private sector, and women without

Text table 1. **Percent distribution of hours worked by educational attainment, men and women, 1948-97**

Year	Years of schooling completed						
	0-8	9-11	12	13-15	16	17 or more	Mean years
Men							
1948	38.4	21.9	25.2	7.3	4.3	2.9	9.7
1958	31.0	21.0	27.9	9.4	6.2	4.5	10.4
1968	18.7	18.9	36.4	12.6	8.1	5.3	11.4
1978	9.6	13.4	39.0	18.5	11.4	8.2	12.5
1988	5.7	10.1	38.6	19.7	15.1	10.8	13.1
1997	4.4	7.8	34.8	26.0	18.2	8.9	13.3
Women							
1948	30.3	19.5	39.0	7.1	2.7	1.4	10.1
1958	23.5	20.6	41.6	9.0	3.5	1.7	10.6
1968	14.5	18.5	50.4	11.8	3.4	1.3	11.2
1978	6.7	13.2	50.5	18.6	7.7	3.4	12.2
1988	3.4	8.9	45.7	22.8	13.3	5.9	12.9
1997	2.6	6.3	35.8	31.5	17.6	6.2	13.4

a diploma accounted for almost 50 percent of all of the hours worked by women. By 1997, male workers without a high school diploma supplied slightly more than 10 percent and comparable women supplied slightly less than 10 percent of private sector hours. Conversely, men with at least a college degree comprised about 7 percent of the hours of men in 1948, but more than 25 percent of employed hours in 1997. The corresponding figures for women are approximately 4 percent in 1948 and about 24 percent in 1997.[23]

Wage premiums associated with seniority and total accumulated work experience may reflect increased productivity due to on-the-job training, increases in efficiency that come with experience at performing work tasks, and improved knowledge of the organizational or institutional structures at a workplace. Employer-provided training has been shown to provide high returns.[24] Even if a job provides little formal training, many jobs provide opportunities for informal training or learning by doing. Informal training can take many forms, including coaching by a supervisor, demonstrations of how to perform a task by a sales representative, asking a co-worker how to perform a task, or by simple repetition.

The 1995 BLS Survey of Employer Provided Training (SEPT95) is particularly valuable because it surveyed both employers and their employees.[25] Employer records are an excellent source of formal training data, but employees are likely to be a better source for the large amount of informal training that they receive. Not surprisingly, more than 90 percent of establishments with at least 50 employees provide formal training and nearly 70 percent of employees receive some formal training. Informal training is nearly universal (95 percent).

During the 6-month survey period, employees trained for about 44 hours, with more than 70 percent of that time spent in informal training. The time spent in training represents a considerable investment. Establishments paid an average of $647 in wages while workers were in training. This is more than four times the direct cost per employee of $139 for tuition, instructors, and payments to outside trainers.

Who receives training varies considerably. The youngest employees (24 years or younger) and the oldest employees (55 years or older) are less likely to receive any formal training, and those receiving formal training spend much less time in it. Employees 25-54 years old also receive more hours of informal training, although the distribution of informal training is less skewed. Women are more likely than men to receive formal training, but men receive most of the informal training. Finally, the likelihood of receiving formal training increases with educational attainment.

It was widely thought that newly hired workers received the most training because this maximized the time employers had to recoup their investment.[26] However, the SEPT95 found the reverse. Employees with at least 10 years' tenure received twice as many hours of formal training as an employee with less than 2 years with the firm. Recently hired workers tended to be trained informally as they spent more than twice as much time in informal training as employees with at least 10 years' tenure.

Text table 2. **Mean years of work experience in private business by sex, 1968-97**

Year	Men	Women
1968	19.4	13.0
1970	19.3	13.0
1975	18.3	12.0
1980	17.5	11.6
1985	17.4	11.7
1990	17.8	12.1
1995	18.6	12.4
1996	18.7	12.5
1997	18.8	12.5

Although the SEPT95 provides a glimpse into the importance and the distribution of training, it can not indicate if employers are increasing the amount of training of their workers over time. Instead, economists have approximated the amount of training by the amount of time a worker has been employed. Because data on total accumulated work experience have not been available, many labor economists use potential experience, or years since leaving school, as a broad index of skills acquired at work.

Data on actual work experience are preferable to data on potential work experience for this purpose, because the labor force participation of women is often intermittent. Large sets of confidential administrative record data on employment, from the Social Security Administration, occasionally have been matched to microdata from the Current Population Survey (CPS) to construct data sets that could be used for analytical purposes.[27] The BLS Office of Productivity and Technology maintains estimates of actual accumulated work experience based on these matched records. Text table 2 provides estimates showing that the average number of years worked declined for both men and women in the 1970s, but rose in the 1980s and 1990s.

The patterns of work experience shown in text table 2 are easily understood. Because most men and many women have strong attachments to the workforce, the level of work experience depends primarily on the age distribution of the workforce. The age distribution of the workforce is now dominated by large cohorts of persons born between 1946 and 1962, who began to enter the workforce in the mid-1960s. During the 1970s, as their numbers grew, the average level of work experience declined. By 1980, most of the baby boom generation had completed its entrance into the workforce, and the leading edge of this cohort was approaching middle age. During the 1980s and 1990s, the baby boomers went from being a large group of inexperienced workers to becoming a middle-aged and experienced group, and average work experience levels rose rapidly.

Average levels of education and work experience, weighted by hours of employment, both show that skill levels rose after 1980. But it is difficult to gauge how much impact these changes had on the economy. Therefore, as part of its productivity measurement program, BLS has used data on the education and experience composition of hours of employment to construct a broad measure of changes in the skill composition of the workforce.

As noted above, an hour of work provides a different contribution to output over time as the workforce becomes more or less skilled. BLS constructs an overall index of labor services that reflects both changes in the number of hours worked and in the average skill level of an hour of work, where skills are measured by education and work experience for men and women. In addition, a second BLS index, the labor composition index, removes the effect of changes in the number of hours worked and focuses exclusively on changes in the average skill level of the workforce. The labor composition index generally rises if there is a shift toward more educated or more experienced workers, or if the wage rates commanded by high-skilled workers increase.

BLS compiles data on roughly 1,000 groups of workers, cross-classified by their educational attainment, work experience, and sex, to create a single index that captures changes in the skill-composition of the U.S. workforce. (See box, p. 44.)

The index of labor services grew about 1.9 percent per year since 1968. This growth reflects the more rapid growth of hours employed among highly-educated workers and, especially since about 1980, an increasing share of total hours worked by middle-aged workers who are in their peak earnings years. Of this increase, labor quality contributed about 0.4 percent per year, whereas the annual average contribution of hours was 1.5 percent. Therefore, increases in skills accounted for roughly 19 percent of the growth in labor services.

The contribution of labor composition to output growth is the product of the growth rate of labor composition and labor's share of total production costs. Labor's share averaged 69 percent over this period. Labor quality, or increases in the average skill level of the workforce, therefore, added about 0.2 percent per year to output growth over the period 1968-97.

Skill Composition of the U.S. Workforce

For each category of worker, growth in hours at work is weighted by that category's share of the total wage bill. This weighted average is an index of labor services. An index of total hours, in contrast, implicitly weights the growth rate of hours of each group of workers by its share of total hours, regardless of differences in wage rates paid for different kinds of work. The labor services index differs from an index of total hours because the labor services index places more weight on the hours growth rates of high-skilled, high-wage workers and less weight on the growth rate of hours of low-skilled, low-wage workers.

Changes in the labor composition index are calculated as the difference between this weighted average of hours growth rates, on the one hand, and the unweighted growth rate for the hours of all workers in the private sector, on the other.[28] Conceptually, a 1-percent increase in the labor composition index has the same effect on output growth as a 1-percent increase in hours worked. That is, the rate of growth of total labor services can be viewed as the sum of the rates of growth of labor quantity (total hours) and labor quality (labor composition effect).

Before turning to the estimate of skill change, it is useful to examine the assumptions that the measures rest upon. Besides those assumptions needed for model production, asumptions of competitive capital and labor markets are fundamental to the labor composition measures.[29] These assumptions permit hourly earnings to be used to measure each type of worker's contribution to output and, therefore, as a measure of skill.

Of course, the wages of some workers may not be strictly the result of competitive labor markets. Occupational and industrial wage differentials are persistent over time, even after controlling for differences in education and work experience.[30] A number of explanations for these differences have been suggested; some are consistent with competitive markets while others are not.[31] One of the assumptions that is consistent with the approach discussed here is that industry-specific wage differentials reflect differences in the training requirements by industry for workers whose education and work histories are otherwise comparable. Employers who have invested significant amounts of time and money to train their employees in industry-specific skills will pay enough of a premium to retain them.[32]

Similarly, unionized workers earn more, on average, than nonunionized workers. Nonetheless, competitive firms will attempt to equate the prevailing wage, however it is determined, to the value of the worker's marginal product by adjusting the level of employment or by screening workers to hire only the most skilled. For example, Allen[33] finds that the occupational mix of unionized workers implies that they are more skilled than nonunionized workers in the construction industry and, thus, at least a portion of the union wage differential is offset by higher marginal products of unionized workers. So, while earnings may not equal the value of marginal products for all workers in all periods, it is assumed that any deviations from the competitive market are temporary and rapidly eroded so that hourly wages approximate marginal products.

Text table 3 shows that the labor composition index advanced quite slowly until about 1979 and increases in skills accounted for little of productivity growth. Since then, the baby boom cohort entered their prime earnings years and labor composition growth has advanced much more rapidly. Skills have become a more important source of productivity growth since 1979. Labor composition effects now account for more than a quarter of all growth in labor productivity.

As noted at the beginning of this section, the baby boom generation made its entrance into the workforce in the 1970s, and this large cohort of inexperienced workers largely offset increases in average schooling levels. After 1979, the baby boom generation gained sufficient experience so that increases in educational attainment and experience both contributed to faster labor composition growth. By 1990, the baby boom generaeration joined the ranks of prime age workers, and even the slower growth in average schooling levels was not sufficient to prevent an acceleration in the average skill level.

Today, the baby boom generation has largely entered middle age, the prime earnings period of a worker's career. Members of this cohort are not expected to make substantial new investments in education and training, since the expected benefits

Text table 3. **Labor composition and its contribution to labor productivity in private business, 1968-97**

Period	Average annual growth rates		
	Labor composition effect	Contribution of increased skill to labor productivity	Labor productivity
1968-73	0.09	0.05	2.66
1973-79	.04	.03	1.27
1979-90	.49	.34	1.22
1990-97	.60	.41	1.30

of these investments would only accrue for a relatively short time until retirement. These workers will gain additional work experience as they grow older, but their earnings will not increase as rapidly as they have during the earlier stages of their careers, when they received more intensive training.

It is also noteworthy that currently middle-aged workers have produced a relatively large cohort of children, known as the "baby boom echo". Members of this younger large cohort are now approaching working age, and early signs of their entrance into the workforce are beginning to appear in the labor force data. This new, large cohort of inexperienced workers will increase the share of the labor force with relatively low earnings. The effect of this shift will be to slow labor composition growth as a larger fraction of the workforce once again becomes younger and less experienced.

Skill Change and Shifts in Industries and Occupations

The United States is enjoying the longest economic expansion since World War II. However, growth has been uneven. Employment in some industries and occupations has risen rapidly while in others it has declined. As seen in the previous section, there is evidence that labor force skills are increasing. By examining employment patterns by industry and occupation, we can gain a clearer understanding of the forces driving skill change in the U.S. workforce.

There is evidence of skill upgrading over the last three decades.[34] However, skill upgrading is not uniform across all industries, nor is it uniform for all occupational groups. Changes in the industrial composition of employment and in the occupational composition of employment within industries can change average skill levels in the overall economy, as can changes over time in the average skill level of given occupations.

This section reviews findings on the pattern of skill change from 1989 through 1997, based on data from the BLS Occupational Employment Statistics (OES) survey. Data on occupational employment and wages by industry from the OES were used to measure changes in average skill levels in the United States resulting from shifts in both the structure of occupational employment within industries, and from shifts in the industrial structure of employment.[35] (See box for a description of skill measure.)

Sources of skill change

Skill change occurs through three paths. First, industries vary in their relative need for skilled workers. Changes in employment across industries can lead to increased employment of skilled workers if expanding industries require workers of greater skill than declining industries, even if the occupational structure of each industry remains constant. Next, changes in production methods within an industry can substantially alter the nature of work. The shift between production and nonproduction workers, noted earlier, is one example. Third, some changes are subtle, leading to changes in the mix of narrowly defined occupations, while leaving the mix of broad occupations unchanged. For example, the computer revolution has transformed secretaries into administrative assistants who now perform word processing instead of typing.

The measure of skill change was produced for the economy as a whole, the goods-producing sector, the service-producing sector, and for six Standard Industrial Classification (SIC) industry divisions (not including agriculture, forestry, and fishing). Text table 4 shows this overall measure of skill change, as well as the decomposition of this measure into skill change resulting from shifts in the industrial composition of each sector, and skill change within detailed industries. The difference between the overall skill change

OES Measure of Skill Change from 1989 to 1997

The OES skill change index measures changes in the relative demands for occupations of differing skill levels in detailed industries over time. Shifts in the relative demand for an occupation are measured by the change in the portion of the wage bill that firms allocate to that occupation. The change in the portion of the wage bill is used rather than the change in the portion of employment as a means of gauging the true resource expenditure involved. For example, when a firm demands one additional manager, the commitment of resources is greater than the case of demanding one additional janitor, even though the employment change is the same.

This measure of skill change resulting from shifts in the occupational structure is produced for the goods- and service-producing sectors and for each industry within those sectors. The measure is then disaggregated into skill change resulting from occupational shifts within detailed industries of the sector and skill change resulting from shifts in the industrial structure of employment within the sector. The skill measure developed by OES takes advantage of data at the 4-digit SIC level, the most detailed industry level available. Data at this level of industry detail provide a clear distinction between skill change resulting from shifts in occupational employment within industries versus that due to shift in industrial composition.

Changes in an occupation's share of the wage bill are calculated as follows: The wage bill for each industry is first calculated by multiplying the total industry employment of each occupation by its wage rate, and summing across all occupations in the industry. Each occupation's portion of the wage bill is then calculated by multiplying the employment for each occupation by its wage rate, and dividing by the total industry wage bill.[36]

Changes in each occupation's share of the wage bill are then weighted by a measure of the skill level of the occupation—the occupation's relative wage, expressed as a percentage deviation from the industry average wage. Relative wages are used as a measure of relative skill assuming that wages, on average, reflect the value of a worker's production. Workers who earn more are assumed to have higher underlying skills. Summing these weighted changes produces a positive or negative value that serves as a measure of relative skill upgrading or downgrading, respectively. This index is comparable across industries; if the skill index increases 5 percent in industry A and 10 percent in industry B, then industry B exhibits twice the rate of occupational upgrading as does industry A.

This skill change index measures the percentage change in the average wage of the industry that is implied by the pattern of shifts in the relative demands for occupations of differing skill levels (i.e., wage rates). It is an index of the degree to which inter-occupational shifts in relative demand within the industry are biased toward or away from relatively skilled workers.[37]

index (column 1) and the index that measures shifts in the industrial composition of employment (column 2) is the effect of occupational shifts within detailed industries (column 3). The measure of skill change within detailed industries (column 3) uses the same concept of skill, but it represents an average of the measures produced for each 4-digit SIC industry, the most detailed industrial category available.

Overall skill change

Average skill levels in the economy as a whole increased about 1.1 percent over the 1989-97 period. Skill levels rose by 0.2 percent in the goods-producing sector, and by 1.4 percent in the service-producing sector. Across the broad occupational spectrum, there was a shift away from less-skilled workers and toward more highly-skilled workers. This shift was due primarily to industries within the service-producing sector.

For the period from 1989 to 1997, the overall index shows that employment shifts led to an increase in average skill levels of about 2 percent in service industries, 3 percent in finance, insurance, and real estate, and 0.4 percent in manufacturing. Average skill levels fell in all other industries, most notably the trade sector, which had an overall skill change measure of -2.0 percent.

Text table 4. **Skill change by sector and industry, 1989-97**

Industry	Skill changes due to shifts—				
			Within detailed industries		
	Overall Skill change	Across industries	Total within industry skill change	Decomposition of within industry skill change:	
				Among broad occupational groups	Within broad occupational groups
	(1)	(2)	(3)	(4)	(5)
All Industries	1.1	0.1	1.0	0.4	0.6
Goods-producing sector:	.2	([1])	.2	- .2	.4
Mining and Construction	- 0.8	- .3	- 0.5	- .8	.3
Manufacturing	.4	([1])	.4	.1	.3
Service-producing sector:	1.4	.2	1.2	.6	.6
Finance, insurance, and real estate	3.0	1.3	1.7	1.4	.3
Services	2.1	- .7	2.8	1.5	1.3
Transportation, communications, public utilities	- .6	- 1.1	.5	.9	- .4
Trade	- 2.0	- .3	- 1.7	- 1.7	([1])

[1] Indicates value is less than 0.05 percent and greater than -0.05 percent.

Skill change resulting from shifts in industrial composition

A shift in industrial composition increases the measure of skill change if employment shifts toward high wage industries. Conversely, industrial shifts will reduce skill change if employment shifts toward lower paid industries. Column 2 of text table 4 shows the portion of skill change that is due to shifts in industrial composition.

Skill levels rose slightly in the economy as a whole (0.1 percent) due to shifts in industrial composition toward higher-wage industries. This effect was greater in the service-producing sector (0.2 percent), driven by finance, insurance, and real estate, which experienced strong shifts toward higher wage industries. Wage-weighted employment shifts between detailed industries contributed negatively to skill change for mining and construction, services, transportation, and trade, while having a neutral effect on skills in the remaining industries.

The positive effect on skill change within the financial services sector is largely the result of large shifts toward securities and commodities brokers and other credit institutions that have gained in importance as a result of the stock market boom of the last half decade. Depository institutions lost over 8 percent of total sector employment over this period.

Skill change arising from occupational shifts within detailed industries

This section discusses changes in skill levels arising from occupational shifts within industries. Shifts in the occupational structure within detailed industries increase average skill levels in the sector if, on average, there is *occupational upgrading*, or a shift toward relatively highly paid occupations within the detailed industries. Column 3 of text table 4 shows this average measure of skill change for the detailed industries within each sector—total within industry skill change. Skill levels increased in the economy as a whole as a result of shifts in occupational employment within industries over the 1989-97 period, led by services sector industries with an average rate of occupational upgrading of 2.8 percent. Industries in the mining and construction sector, and in trade, had average declines in skill levels as a result of shifts in occupational employment.

Changes in skill levels arising from occupational shifts within detailed industries can be further differentiated into employment shifts *among* broad occupational groups (such as between professional and clerical, shown in column 4) and shifts *within* broad occupational groups (such as between secretaries and data processors, shown in column 5).[38] The "among" effect reflects gross changes in the occupational structure. The "within" effect reflects more subtle alterations to

Text table 5. **Index of skill change for broad occupational groups, 1989-97**

Occupational groups	Skill index		
	All industries	Goods-producing sector	Service-producing sector
All occupational groups	1.0	.2	1.2
Managerial	- .4	.4	- .7
Professional	.7	- .1	1.0
Clerical	.3	.6	.2
Sales	.8	- 1.0	1.4
Service	- .8	- 2.1	- .3
Production I [2]	.6	.8	.5
Production II [3]	([4])	([1])	([4])

[1] Indicates value is less than 0.05 percent and greater than -0.05 percent.
[2] Includes production supervisors; inspectors; mechanics, installers, and repairers; construction trades and extractive occupations; and precision production occupations.
[3] Includes machine setters, set-up operators, operators, and tenders; hand working production occupations; plant and system occupations; transportation and material moving machine and vehicle operators; and helpers, laborers, and material movers, hand.
[4] Data do not meet publication standards.

the occupational mix within industries.

This decomposition shows that employment shifts among broad occupational groups worked to increase average skill levels in all industries with the exception of trade and mining and construction. Table 2-1 (at end of chapter) shows that the pattern of employment shifts most responsible for the increase in skills within service sector industries are shifts toward professional workers, who earn relatively high wages, and away from clerical workers, who earn relatively low wages. Although the goods-producing sector mirrors this shift away from clerical workers, there was no shift toward professional workers in that sector.

Skill change within broad occupational groups. Column 5 of text table 4 shows the average amount of skill change within detailed industries that is the result of occupational shifts within broad occupational groups. This measure indicates occupational upgrading or downgrading, or the degree to which shifts in occupational employment within broad occupational groups are biased toward or away from relatively high- or low-wage workers, respectively. All industry groups experienced occupational upgrading within occupational groups, with the exception of transportation and trade. Closer examination of this effect, however, reveals that skill levels did not increase for every occupational group. Text table 5 shows the average measure of skill change for occupational groups within industries in the goods-producing and service-producing sectors. (For more details, see table 2-2.)

Text table 5 shows that the economy as a whole and both the goods-producing and service-producing sectors experienced occupational upgrading in the clerical and production I groups, along with occupational downgrading in the service group. Skill changes for other broad occupational groups were mixed.

Table 2-3 shows the average pattern of relative demand shifts among detailed occupations within the clerical, production I, and service occupation groups. Occupational upgrading among clerks within detailed industries is the result of a shift toward clerical supervisors, who earn relatively high wages, and a shift away from secretaries and data processors, who earn relatively low wages. Occupational upgrading among production I occupations is due to a shift toward first line supervisors and away from inspectors and precision production occupations. Occupational downgrading among service occupations is primarily due to shifts away from service worker supervisors and protective service workers, and toward workers in personal and health services occupations.

Summary

Shifts in employment patterns indicate occupational upgrading over the 1989-97 period. Average skill levels increased for the economy as a whole, driven primarily by increases in average skill levels in both the services and finance, insurance, and real estate industries. Skill levels increased slightly in manufacturing industries and fell in mining and construction, transportation, and trade. By decomposing these figures into skill

Text table 6. **Highlights of occupational employment changes by broad education and training categories, 1986-96**

Education and training category	Growth rate 1986–96 (in percent)	Numerical growth 1986–96	Percent of overall job growth
Total, all occupations	19	21,068,780	100.0
Bachelor's and above	29		
First professional degree	16	201,277	1.0
Doctoral degree	-2	-3,620	([1])
Master's degree	44	518,917	2.5
Work experience, plus a bachelor's or higher degree	32	2,313,970	11.0
Bachelor's degree	29	3,623,663	17.2
Postsecondary education and training below the bachelor's degree	14		
Associate degree	37	1,130,078	5.4
Postsecondary vocational training	5	413,063	2.0
On-the-job training or experience	17		
Work experience in a related occupation	19	1,202,526	5.7
Long-term OJT	11	1,199,188	5.7
Moderate-term OJT	11	1,888,523	9.0
Short-term OJT	20	8,581,195	40.7

[1] Slight decline.

change resulting from shifts in industrial employment and shifts in occupational employment, it is apparent that occupational upgrading within detailed industries was the primary source of skill change.

Analysis of Trends in the Education and Training Requirements of Occupations

An analysis of trends in the educational requirements of occupations between 1986 and 1996 suggests that technological and other demands of the economy placed a premium on occupations requiring higher levels of education and training. Industry-occupation matrices developed by the BLS Office of Employment Projections (OEP),[39] show occupational staffing patterns over time. The matrices are developed from data on occupational employment by industry collected through the OES survey.[40]

Shifts in industry and occupational employment were analyzed in the context of the classification system developed by OEP that places occupations into 1 of 11 different categories based on the education, training, or experience that usually is required.[41] The 11 categories are distributed to three summary groups (See box).

Overall changes in occupational skill across industry sectors

Total employment in the United States increased 21.1 million over the 1986-96 period, from 111.4 million to 132.4 million. (See text table 6.) Occupations at all education and training levels, except the doctoral degree, experienced increases, with the largest numerical growth (41 percent) in short-term on-the-job training. Employment in occupations usually requiring at least a bachelor's degree grew by 29 percent over the 1986-96 period, considerably faster than the 19-percent growth for all occupations. Occupations generally requiring postsecondary education or training below the bachelor's degree and those that require on-the-job training or experience had slower than average employment growth, 14 percent and 17 percent, respectively.

Chart 2-1 shows the 1986-96 employment changes by broad education and training category and earnings level. Each of the three bars shows the distribution of the increase in employment by earnings above or below the average. For occupations requiring a bachelor's degree and above, 97 percent of the increase was in occupations with above average earnings. In contrast, the percent with above average earnings was lower in occupations requiring postsecondary education and training (below the

Occupational Education and Training Categories

Bachelor's degree and above

First professional degree. *Occupations that require a professional degree*. Completion of the academic program usually requires at least 6 years of full-time equivalent academic study, including college study prior to entering the professional degree program.

Doctoral degree. *Occupations that generally require a Ph.D. or other doctoral degree*. Completion of the degree program usually requires at least 3 years of full-time equivalent academic work beyond the bachelor's degree.

Master's degree. *Occupations that generally requires a master's degree*. Completion of the degree program usually requires 1 or 2 years of full-time equivalent study beyond the bachelor's degree.

Work experience, plus a bachelor's or higher degree. *Occupations that generally require work experience in an occupation requiring a bachelor's or higher degree*. Most occupations in this category are managerial occupations that require experience in a related non-managerial position.

Bachelor's degree. *Occupations that generally require a bachelor's degree*. Completion of the degree program generally requires at least 4 years but not more than 5 years of full-time equivalent academic work.

Post secondary education or training below the bachelor's degree

Associate degree. *Occupations that generally require an associate's degree*. Completion of the degree program generally requires at least 2 years of full-time equivalent academic work.

Post-secondary vocational training. *Occupations that generally require completion of vocational school training*. Some programs last only a few weeks while others may last more than a year. In some occupations, a license is needed that requires passing an examination after completion of the training.

On-the-job training or experience

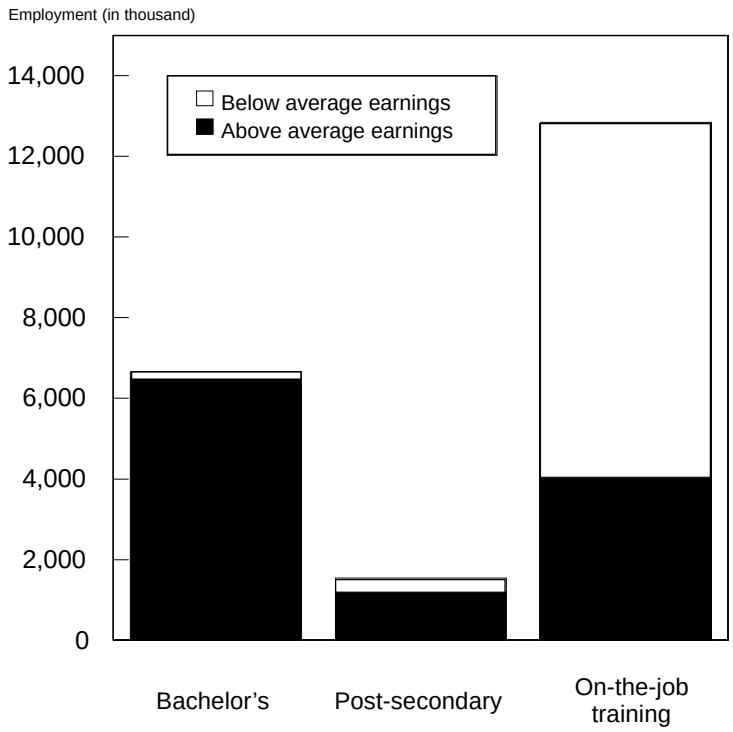
Work experience in a related occupation. *Occupations that generally require skills obtained through work experience in a related occupation*. Some occupations requiring work experience are supervisory or managerial occupations.

Long-term on-the-job training. *Occupations that generally require more than 12 months of on-the-job training or combined work experience and formal classroom instruction for workers to develop the skills needed for average job performance*. This category includes formal and informal apprenticeships that may last up to 4 years and short-term intensive employer-sponsored training that workers must successfully complete. Individuals undergoing training are generally considered to be employed in the occupation. This category includes occupations in which workers may gain experience in non-work activities, such as professional athletes who gain experience through participation in athletic programs in academic institutions.

Moderate-term on-the-job training. *Occupations in which workers can develop the skills needed for average job performance after 1 to 12 months of combined on-the-job experience and informal training.*

Short-term on-the-job training. *Occupations in which workers generally can develop the skills needed for average job performance after a short demonstration or up to one month of on-the-job experience and instruction.*

Chart 2-1. **Change in occupational employment by earnings and training category, 1986-96**



NOTE: Complete categories are: Bachelor's degree and above; Post secondary education and training below the bachelor's; and On-the job-training or experience.

bachelor's) and on-the-job training or experience (77 percent and 31 percent, respectively).

Shifts in the distribution of industry employment are important determinants of shifts in the distribution of occupational skill requirements. The most rapid growth of employment over the 1986-96 period was in the services sector (40 percent). This resulted in faster than average employment growth within services in all occupations in each of the three summary groups of occupations. This reflects the dynamic that when firms grow rapidly enough, the demand for lower-skilled labor can rise, even though some of their traditional duties are being done more efficiently by more highly trained workers or through technological innovation. However, the top group (bachelor's and above) increased its share of sector employment at the expense of the other two groups.

In manufacturing, employment declined slightly over the period.[42] Because overall manufacturing employment fell, only those occupations in the highest education and training category had higher employment in 1996 than they did 10 years earlier. Occupations requiring at least a bachelor's degree increased their share of manufacturing employment as both groups of lower skilled occupations became relatively less important to employers.

These data are indicative of increased relative employment of college educated workers. However, this pattern may arise because employment growth in some education and training categories was driven by the rapid growth of a single occupation or only a small number of occupations. For example, almost all of the growth in occupations requiring an associate degree resulted from growth in a single occu-

Text table 7. **Occupations accounting for the largest share of employment growth, bachelor's degree and above, 1986-96**

Education and training category	Occupations accounting for the largest share of growth (ranked by share)	Industries contributing to growth in category	Number of occupations in category	Earnings
First professional degree	•Lawyers •Physicians	•Health services •Legal services •Agricultural services •Federal/State government	6	Top quartile
Doctoral degree	•Biological scientists	•Drug manufacturing •Federal/State/ local government	4	Top quartile
Master's degree	•Teachers and instructors, all other •Counselors •Speech-language pathologists and audiologists •Physchologists	•Education •Amusement and recreation •Health services •Government	9	Top two quartiles
Work experience, plus a bachelor's or higher degree	•Managers and administrators, all other •Financial managers •Marketing, advertistingand public relations managers •Management analysts	•Business services •Health services •Local government •Education •Real Estate	11	All but 3 occupations in top quartile (one wage not available)
Bachelor's degree	•Teachers, preschool through college, except special and adult education •Computer engineers, scientists, and systems analysts •Management support workers and professional workers, all other	•Education •Business services •Health services •State and local government •Residential care	56	45 occupations in top quartile 9 occupations in second highest quartile 2 occupations with below average earnings

pation, registered nurses. Similarly, the growth of lawyers and physicians drove the growth for occupations that usually require a first professional degree.

Occupational shifts by educational requirements

The following sections discuss employment changes in specific education and training categories. In addition to highlighting occupations accounting for the largest share of employment growth, text tables 7 through 9 show those industries contributing significantly to growth within each education and training category. Job growth can also be stratified by earnings. As part of the analysis of the 1986-96 time series, median hourly earnings of all wage and salary workers in 1996 by occupation, as measured by the Occupational Employment Statistics (OES) survey, were used to construct earnings quartiles. The last column of text tables 7-9 distributes occupations within each education and training category by earnings quartile. Earnings in either of the bottom two quartiles are below the average.

Bachelor's degree and above. Lawyers and physicians accounted for more than 80 percent of job growth among occupations requiring a first professional degree, but neither of these occupations grew as fast as the average for all occupations. A single occupation—all other teachers and instructors, which includes lecturers, nursing instructors,

Text table 8. **Occupations accounting for largest share of employment growth, postsecondary education and training below the bachelor's degree, 1986-96**

Education and training category	Occupations accounting for the largest share of growth (ranked by share)	Industries contributing to growth in category	Number of occupations in cagetory	Earnings
Associate degree	•Registered nurses •Health professionals and paraprofessionals, all other	•Health services •Drug stores and proprietory stores •Business services	12	11 occupations in the two highest quartiles 1 occupation with below average earnings
Postsecondary vocational training	•Emergency medical technicians •Licensed practical nurses •Secretaries, except legal and medical	•Business services •Health services •Education •Religious organizations	33	25 occupations in top two quartiles 8 occupations in with below average earnings

graduate assistants, sports instructors, and farm and home management advisors—accounted for 65 percent of new jobs at the master's degree level. Teachers, preschool through college, accounted for 886,000, or 24 percent, of the growth of the group usually requiring a bachelor's degree. However, employment of computer engineers, scientists, and systems analysts; all other therapists; physician assistants; and occupational therapists each more than doubled over the period. Nearly all of the occupations requiring a bachelor's degree or above had median earnings in the top quartile.

Postsecondary education and training below the bachelor's. Rising demand for workers in health-related occupations was the driving force behind job growth for occupations included in this group. About three-fourths of the growth in occupations requiring an associate degree occurred in the health services industry. Registered nurses accounted for one-half of all growth in this group. All other health professionals and paraprofessionals, radiologic technologists and technicians, medical record technicians, dental hygenists and respiratory therapists brought the health related share of job growth in this category to about 95 percent. More than one-half of the new jobs generated by the occupations in the postsecondary vocational training category can be attributed to four health-related occupations: Emergency medical technicians, licensed practical nurses, medical secretaries, and surgical technologists. All but eight of the occupations in this category had higher than average earnings. (See text table 8.)

On-the-job training or experience. A little more than one-half of the growth in occupations commonly requiring applicants to have work experience in a related occupation, or long-term on-the-job training, occurred in eating and drinking places, education, State and local government, and business services like personnel supply services. Nearly 60 percent of the growth in occupations that usually require moderate-term on-the-job training occurred in business and health services, grocery stores, and construction. Four occupations accounted for 92 percent of job growth in the moderate on-the-job training category—all other sales and related workers, composed largely of sales workers in wholesale trade and manufacturing; bookkeeping, accounting, and auditing clerks; medical assistants; and human services workers. In general, median earnings of occupations requiring work experience in a related occupation or long-term on-the-job training were higher than the average for all occupations. (See text table 9.) Just 3 of the 107 occupations requiring moderate-term on-the-job training had median hourly earnings in the highest quartile, although slightly more than one-half of the occupations had above average earnings.

The 20-percent growth in occupations that generally require short-term on-the-job training was concentrated in two industry sectors, wholesale and retail trade and services, accounting for about 90 percent of the growth, or about 7.4 million jobs. Occupations that generated at least 100,000 jobs and grew at least twice as fast as the overall average accounted for 49 percent of the

Text table 9. **Occupations accounting for largest share of employment growth, on-the-job training or experience, 1986-86**

Education and training category	Occupations accounting for the largest share of growth (ranked by share)	Industries contributing to growth in category	Number of occupations in cagetory	Earnings
Work experience in a a related occupation	•Service workers, all other •Clerical supervisors and managers •Adult and vocational education teachers •Food and service and lodging managers	•Eating and drinking places •Education •Business services •State and local government •Health services	30	22 have earnings in the top two quartiles 8 have earnings below average
Long-term OJT	•Maintenance repairers, general utility •Cooks, restaurant •Correction officers •Musicians •Telephone and cable •TV line installers and repairers	•State and local government •Eating and drinking places •Construction •Business services •Religious organizations	74	22 occupations in top quartile 30 in second highest quartile (one wage not available) 21 occupations with below average earnings
Moderate-term OJT	•Sales and related workers, all other •Bookkeeping, accounting, and auditing clerks •Medical assistants	•Business services •Health services •Grocery stores •Construction •Wholesale trade, other	107	59 occupations in top two quartiles 48 occupations with below average earnings
Short-term OJT	•Cashiers •General office clerks •Janitors and cleaners, including maids and house-keeping cleaners •Truckdrivers, light and heavy •Salespersons, retail	•Retail trade •Business services •Health services •Educatiion •Trucking, warehousing, and transportation	114	1 occupation in to quartile 15 in second quartile 98 occupations with below average earnings, including 39 in the bottom quartile

growth in occupations requiring short-term on-the-job training. These included cashiers, hand packers and packagers, receptionists and information clerks, home health aides, teacher aides and educational assistants, adjustment clerks, child care workers, counter and rental clerks, bill and account collectors, personal and home care aides, and amusement and recreation attendants. This is the only education and training category with most occupations having below average earnings. Only one, industrial truck and tractor operator, had earnings in the top quartile.

Quality of job growth

Another way to view changes in skills is to examine changes in the distribution of earnings, since most economists associate high wages with a high level of skills. As part of the analysis of the 1986-96 occupational employment time series, median hourly earnings of all wage and salary workers in 1996 by occupation as measured by the Occupational Employment Statistics survey were used to construct earnings quartiles. Median hourly earnings ranged from $60.01 to $5.01 for the 456 occupations included in the 1986-96 time se-

Text table 10. **Employment by earnings quartile, 1986 and 1996**

Earnings quartile	Range of median hourly earnings, 1996[1]	Percent distribution		
		1986 employment	1996 employment	Employment change, 1986-96
Total	$ 5.01-60.01	100.0	100.0	100.0
1	60.00 -115.39	23.9	25.1	31.1
2	15.39 -10.63	24.6	24.6	24.7
3	10.61 -7.51	26.5	25.5	20.1
4	7.47 -5.01	25.0	24.8	24.1

[1] Nominal.

ries.[43] The range of earnings varied among the quartiles and the top quartile had the widest range. (See text table 10.) Employment size significantly affected the distribution of occupations by quartile. Of the 454 occupations in the distribution of employment, the first quartile included 112 and the second, 152. The third quartile contained 134 occupations and the fourth, 56.

The highest earnings quartile's share of growth between 1986-96 was disproportionately high, at 31.1 percent; the lowest quartile's share was 24.1 percent. The first quartile showed the greatest occupational growth and the third quartile, the least. This reflects the different growth rates for occupations in the different quartiles.

The distribution of employment growth by quartile was affected significantly by the concentration of occupational growth. Of the 454 occupations, 16 accounted for 50 percent of the change in employment from 1986 to 1996.[44] Five of these occupations were in the top earnings quartile; three each were in the second and third quartiles, and five were in the lowest quartile.

What do these trends really tell us?

The high rates of growth over the 1986-96 period for occupations requiring at least a bachelor's degree clearly indicate that the economy is placing an increasing emphasis on workers with extensive higher education. This is confirmed by the rapid growth of occupations with the highest earnings, which are highly correlated with educational attainment. Nevertheless, despite employers' growing need for these highly educated workers to handle increasingly complex tasks, 2 of every 3 jobs created over this period were in occupations that do not require a degree. Shifts in employment across education and training categories occurred slowly, since the rapidly growing, high-education occupations account for a relatively small share of employment. For example, despite their rapid employment growth, occupations that generally require at least a bachelor's degree increased their share of employment by only 1.8 percentage points over the period, from 20.3 percent to 22.1 percent.

While part of the economy is characterized by industries undergoing rapid technological change, the rest is characterized by activities that change relatively slowly. For these dramatically changing sectors, consumer demand and changing demographics provide a strong impetus for continued growth in lesser skilled jobs.

Relationship between Earnings and Skill

The generally increased skill level of the labor force was the focus of the previous section. We concentrate now on the the more day-to-day concerns of employers and employees on how skills are rewarded. Human capital theory codifies the roles of education and on-the-job training in the acquisition of job skills, and the relationship between these skills and earnings.[45] According to this theory, workers' skills are the primary source of their productivity, although the skills of different individuals may be very different. In the case of the U.S. workforce, these skills are extremely difficult to measure directly. But there is a systematic relationship between education and training, on the one hand, and wage rates on the other, because people acquire skills through education and training. According to human capital theory, firms pay higher wage rates to more educated and experienced workers, all else being equal, because their additional skills raise their productivity compared to workers with less education and work experience. People invest in education and training, both by paying the direct costs and by incurring the opportunity

costs associated with these investments, in order to earn a higher wage rate in the future.

To illustrate the relationship between education and earnings, the following tabulation shows the ratio of hourly compensation of college to high school male and female graduates from 1970 to 1997, holding other characteristics constant.[46]

	1970	*1980*	*1990*	*1997*
Men	1:36	1:29	1:51	1:62
Women	1:23	1:32	1:56	1:65

In 1970, college educated men earned about 36 percent more than high school graduates. Starting around 1980, college educated workers began to fare substantially better than less educated workers. By 1997, the gap had nearly doubled to 62 percent. The results are even more striking for women. College educated women earned 23 percent more than high school graduates in 1970 and 65 percent more in 1997.

Similar patterns can be seen in the relationship between experience and earnings. As noted in the section on broad measures of change in education and work experience, BLS has constructed estimates of actual work experience from the Social Security Continuous Work History file. Analysis of these data reveals that the wage rates of more experienced workers have also increased, relative to the wage rates of younger workers. The tabulation below shows the ratio of hourly compensation of men and women having 15 years to 5 years of experience over the period, 1970 to 1997.

	1970	*1980*	*1990*	*1997*
Men	1:47	1:70	1:70	1:64
Women	1:15	1:22	1:28	1:35

The relative earnings of more experienced women have continued to rise throughout the last 27 years. For men, however, work experience commanded increasing premiums until the mid-1980s; those premiums have remained stable since then.

Other researchers have shown that growing wage inequality also arises within narrowly defined categories of industry, sex, age, and schooling.[47] Many of the economic forces that underlie these increases in the variance of wage rates within narrow industrial and demographic categories have been mentioned in the section on the economic environment. But their effects on wage rates are partially hidden when they are analyzed in terms of broad measures of skill such as earning and experience. Consequently, it is useful to examine the structure of earnings, and particularly the relationship between wage rates and more specific measures of job skills, within broadly defined occupational categories.

Not everyone in a given occupation has the same level of skill, and not all jobs within a given occupation require equal levels of skill. Thus, it is not surprising that wage rates vary within an occupation. Several variables have been identified as having an effect on pay scales—unionized workers generally earn more than their nonunion counterparts; pay rates in the north are higher than those in the south; large establishments pay more than small ones; and men earn more than women for comparable work. While these observations are useful for policy makers, they do not explain the pay setting mechanisms used by individual firms.

John Dunlop, one of the first to describe the interplay of the individual firm and product markets in setting wage rates,[48] noted the importance of the salary level of specific "key" jobs for the pay rates of other jobs within an establishment. The role of key or benchmark jobs is paramount to the job classification and compensation setting schemes commonly used today.[49]

A point-factor pay setting scheme is the most common approach used by compensation analysts in setting pay rates within an establishment.[50] It usually starts with a careful evaluation of jobs within a firm based on a set of defined factors, of which skill is one. Jobs are assessed on how much of each factor they contain. Points are then assigned for each factor, and a total point score is compiled for each job. The point score is then translated into a salary level. Different establishments use different factors and different weights for each factor, reflecting the relative value of each factor to the establishment.

The Occupational Compensation Survey (OCS), and the half century of its predecessor programs, compiled earnings data based on a preselected job list. These surveys were aimed at collecting wages paid for specific jobs; the focus was not on the individuals holding these positions. Jobs were selected as key or representative occupations in an area, industry, or for setting Federal pay scales.

Not all jobs in the same occupation require equal levels of skill or ability. The surveys gathered wage data for various levels within an occupation. Skill requirements ranged from trainee to journeyman, and beyond. The number of levels varied by occupation.

The surveys used detailed job descriptions for each job, as well as various job levels within an occupation. (As an example, see box on p. 56 for

Synopsis of major distinguishing characteristics used to determine job level for two sample occupations under the Occupational Compensation Survey

Budget analyst

Level I: Trainee. Clearly defined tasks. Comparing and verifying data. Preparing budget forms. Examining and highlighting deviations in reports.

Level II: Routine, recurring analysis work. Gathering, extracting, reviewing, verifying, and consolidating data. Examining and comparing budget requests.

Level III: Relatively stable operation analysis. Forecasts funding needs. Reviews and verifies data. Formulates and revises estimates. Explores funding alternatives. Certifies obligations and expenditures. Recommends transfer of funds within accounts.

Level IV: Analytical support for budgets requiring annual modifications. May recommend new budgeting techniques. Cost-benefit analysis and program trade-offs studies. Confers on request modifications. Develops procedures for budget requests. Prepares status reports. Recommends adjustments. Advises management. Serves as budget liaison.

Accountant

Level I: Trainee, learns to prepare financial statements.

Level II: Prepares financial statements, working papers and periodic reports following a set of rules and procedures.

Level III: Maintains conventional and relatively stable accounting system or segment. Solves moderately complex accounting problems and makes decisions.

Level IV: Maintains complex accounting system or segment. Makes frequent recommendations for new accounts, revisions in account structures, new types of ledgers, or revisions in the reporting system.

Level V: Work extends beyond accounting system maintenance. Participates in developing and revising accounting systems and procedures. Works with operating managers to explain how changes in the accounting system will affect them.

Level VI: Complete responsibility for establishing and implementing new and revised accounting systems and procedures. Accounting program is complex. Typically a corporate level job.

a brief synopsis of major distinguishing features used to evaluate various levels for two jobs.)[51] In practice, all the elements in each level definition were considered in making a classification judgment. For example, in some occupations, individuals classified at different levels of an occupation can perform work of essentially the same complexity, but have significant differences in direction received or responsibility for the direction of others.

Table 2-4 shows the proportion of workers at each level for selected occupations surveyed in 1996. Higher level jobs within an occupation require greater skill or knowledge, or both. This higher skill can be a reflection of higher tenure (and associated additional experience and on-the-job training) as well as more education. As shown in table 2-5, earnings also increased for higher levels within an occupation.

Periodic additions and deletions were made to the jobs selected for study in an effort to reflect changing labor market conditions. The definitions and number of levels were also modified from time to time. These changes were relatively slight from one year to the next, but the cumulative effect of these modifications and other changes in the sample design renders it difficult to make comparisons over time.

The OCS survey has been integrated into the National Compensation Survey (NCS), as part of an effort to combine several compensation programs into a single vehicle that can produce local, regional, and national statistics on levels, trends, and characteristics of pay and benefits.[52] Under this umbrella program, the use of a pre-set job list was dropped. In its place, the NCS collects data on randomly selected occupations. BLS economists use a factor evaluation system to

National Compensation Survey: Factor Evaluation System

Factor 1 - Knowledge

1. Knowledge to perform simple tasks, requires little or no previous education/training.
2. Knowledge of commonly used procedures, requires some previous training.
3. Knowledge of standardized rules. Requires considerable training or experience.
4. Knowledge of extensive rules in a generic field to perform a wide variety of tasks.
5. Knowledge of specialized, complicated, techniques. BA/S degree or experience.
6. Knowledge of a wide range of administrative methods. Graduate study or experience.
7. Knowledge of a wide range of concepts or principles. Extended graduate study or experience.
8. Mastery of administrative field to apply experimental theories or new developments.
9. Mastery of administrative field to develop new hypotheses and theories.

Factor 2 – Supervision received

1. Supervisor makes specific assignments, employee closely monitored.
2. Employee handles ongoing assignments, supervisor makes decisions.
3. Supervisor provides objectives and deadlines; employee plans tasks. Review based on conformity to policy.
4. Supervisor sets objectives, employee sets deadlines/plans tasks. Review based on meeting requirements.
5. Supervisor defines mission, employee responsible for all planning. Review in terms of meeting program objectives.

Factor 3 – Guidelines

1. Guidelines are specific and detailed; employee follows them strictly.
2. There is a list of guidelines; employee chooses most appropriate.
3. Guidelines are not always applicable; employee uses judgment in adapting them.
4. Guidelines are scarce but policies are stated; employee may deviate from traditional methods to develop new methodology.
5. Guidelines are broadly stated; employee is a technical authority in development of guidelines.

Factor 4 – Complexity

1. Tasks are clear cut and easily mastered. No decision making.
2. Tasks involve related steps requiring employee to recognize different steps.
3. Tasks involve unrelated methods; employee must recognize them and choose based on relationships.
4. Tasks involve unrelated methods; employee must assess approach.
5. Tasks involve unrelated methods; decisions deal with uncertainty.
6. Tasks involve broad functions; decision making involves undefined issues.

Factor 5 – Scope and effect

1. Little impact beyond immediate organization.
2. Work impacts future processes.
3. Works affects the operation of the program.
4. Work affects wide range of establishment activities or operations of other establishments.
5. Work affects work of other experts or development of major program aspects.
6. Work is essential to the mission of the establishment.

National Compensation Survey: Factor Evaluation System—Continued

Factor 6 – Personal contacts

1. Contacts are with employees in immediate office or with public; highly structured situations.
2. Contacts are with employees in the same establishment (in or out of office) or with public in moderately structured situations.
3. Contacts are with individuals and groups outside the organization. Each contact is different.
4. Contacts are with high ranking officials in unstructured settings.

Factor 7 – Purpose of contacts

1. The purpose is to obtain, clarify, or give facts.
2. The purpose is to plan, coordinate, or advise on work efforts.
3. The purpose is to influence, motivate, interrogate, or control persons or groups.
4. The purpose is to justify, defend, negotiate, or settle matters involving significant/ controversial issues.

Factor 8 – Physical demands

1. Work is sedentary.
2. Work requires physical exertion.
3. Work requires considerable and strenuous physical exertion.

Factor 9 – Work environment

1. Work involves everyday risk—normal safety precautions.
2. Work involves moderate risk—special safety precautions.
3. Work involves high risk.

Factor 10 – Supervisory span of control

1. No supervisory responsibility.
2. Group Leader—nonsupervisory person who leads work activities.
3. First line supervisor.
4. Second line supervisor.
5. Third line supervisor.

evaluate each job. The system is based on 10 "generic" factors:

- Knowledge
- Supervision received
- Guidelines
- Complexity
- Scope and effect
- Personal contacts
- Purpose of contacts
- Work environment
- Physical demands
- Supervisory duties[53]

A weighted value of each factor is then used to assign job levels. See the box on p. 22 for a summary of the criteria used in evaluating each factor.[54]

The occupational levels used by NCS differ from those in the OCS. Under OCS, the lowest level for any given occupation was set as 1, generally an entry-level position. Both skilled and unskilled occupations were classified as level 1. In contrast, NCS uses characteristics and factors to determine occupational levels. Thus, the lowest level for a given NCS occupation need not be 1.

Different occupational groups have different generic leveling profiles. One useful aspect of the generic leveling data is that disparate occupations can be measured on common scales. Table 2-6 presents modal values of three generic factors—knowledge, supervision received, and guidelines—within broad occupational groups.[55] *Knowledge* captures schooling, work experience, and other training used on the job, and is measured on a scale of one to nine. As measured by this factor, professional and executive jobs require large amounts of skill. Technical, clerical, and precision production jobs involve moderate

amounts of this factor, whereas operatives, laborers, and service occupations involve substantially lower amounts of knowledge.

Various occupational groups exhibit differences along other dimensions as well. Thus, table 2-6 also lists modal values for two other factors, each of which is measured on a scale of one to five. *Supervision received* measures the extent of direct or indirect controls exercised by supervisors, such as the degree to which assignment priorities and deadlines are set. *Guidelines* assess the extent to which policies and procedures in the job are made explicit, and the extent to which individual employee judgment in applying policies is required. Occupational groups with higher knowledge measures also tend to have higher measures for these other two factors. Nevertheless, the other factors measure different job attributes that vary independently of knowledge.

Jobs with different levels of the job attributes pay different wage rates, as demonstrated by table 2-7, which shows the mean hourly wage rates for occupations with given levels of knowledge. On average, wages increment by about 30 percent as knowledge increments one level. Other factors, including the other generic leveling factors and other job attributes such as full-time status and occupation, are not held fixed in these comparisons.

Table 2-7 illustrates the substantial differences in hourly wages across jobs within a given occupational category. There is substantial dispersion within the occupational group about the group modal values presented above, and within broad occupational groups. Higher job duties command higher pay. Although there are differences in wages across occupational groups—for instance, Precision Production and Transport jobs tend to uniformly pay more than other jobs with the same level of knowledge—those differences are often small, at least as measured relative to the typical wage differences across adjacent levels of knowledge. Thus, the generic leveling factors capture some characteristics of jobs that are associated with higher wages that are difficult to identify except by recourse to job title. That is, typical professional jobs and typical technical jobs pay very different amounts, but professional and technical jobs with the same level of knowledge pay much the same.

Wage differences across occupational groups for a given level of knowledge partly reflect differences in other job duties or attributes. Wage regression analysis is one way to determine whether this is the case. In essence, regression is a statistical method that allows one to isolate the effects on wage rates of a given factor or variable, holding other variables fixed. Table 2-8 gives the estimated wage premiums to knowledge from such a regression.[56] For example, the first number in the table, 9.5 percent, indicates that jobs with Knowledge=2 pay about 9.5 percent higher than jobs that have Knowledge=1 but that otherwise appear similar.[57] Generally speaking, a one unit increment to knowledge usually raises wages by about 10-15 percent, holding other factors fixed. This is roughly comparable to the wage premium associated with full-time status, or with union coverage.

The wage premiums associated with knowledge are higher than those associated with the other factors. For example, the premiums for increments to supervision received in the same wage regression are all on the order of 7-10 percent, and similarly so for guidelines. There appear also to be some less substantial premiums for the factors of complexity, scope and effect, and supervisory duties. There are, moreover, relatively negligible wage premiums for the other factors, which include measures of how job incumbents interact with others inside and outside of the establishment, and measures of the physical aspects of the job. Therefore, job attributes relating to interpersonal relationships seem not to affect wages, except insofar as they relate to managerial aspects of work. In addition, physically difficult or dangerous jobs seem to pay about the same as jobs that would otherwise have comparable duties.[58]

In sum, results obtained from the NCS survey indicate that the duties most highly valued by the marketplace are generally cognitive or supervisory in nature. To the extent that these measures of job duties or job attributes reflect individual incumbent worker skills, the results suggest that cognitive abilities are quite highly valued by employers. This result is generally in accord with the findings presented earlier in this chapter relating wages to schooling and work related training.

Occupational Shortages[59]

"Evolving technology, shifts in consumer taste, and innovative business practices are among the contributors to progress over the past 35 years and to anticipated growth for the future."[60] Analysis of historical employment trends has shown that technological and other demands in the economy have placed a premium on higher levels of education and training. BLS develops employment projections for more than 500 detailed occupations, which reveal that higher levels of educa-

tion are associated with the fastest employment growth and high earnings.[61] For the 1996-2006 period, the rates of growth range considerably: from an increase of 118 percent for database administrators, computer support specialists, and all other computer scientists to a decline of 75 percent for typesetting and composing machine operators.

Among the 30 occupations that are projected to grow the fastest, educational requirements and earnings of workers are quite varied; about half require education or training beyond high school. In fact, all education and training categories requiring at least an associate's degree or higher are projected to grow faster than average and have higher than average earnings.

Projections indicate that occupations requiring a bachelor's degree will grow almost twice as fast as the average for all occupations. The top three fastest growing occupations, which are all computer-related, require at least a bachelor's degree and, in 1996, had median weekly earnings that were much higher than average for all full-time wage and salary workers.

Not all of the occupations projected to grow the fastest, however, are in fields requiring postsecondary education. Six of the top 10 fastest growing occupations require varying levels of on-the-job training. These include occupations such as personal and home health aides, medical assistants, desktop publishing specialists, and physical therapy assistants. Despite the fact that jobs usually requiring an associate degree or higher are expected to grow faster than average over the 1996-2006 period, the majority of occupations with the largest expected job growth will require less than an associate degree.

Whenever there is sustained rapid employment growth, there is potential for concern on the part of employers and others about occupational shortages. Labor shortages occur in a market economy when the demand for labor in a particular occupation exceeds the supply of workers who are qualified, available, and willing to do that job. Jobs go vacant as employers seek to hire more workers than are willing to work at the prevailing wage or salary.[62]

The term "labor shortage" is often used to describe a variety of situations, some of which are not generally considered by economists to be actual shortages. When labor is plentiful, employers become accustomed to hiring workers with specific training or levels of experience. When the labor market tightens, however, the number of job applicants is likely to shrink, and employers may have difficulty finding that same caliber of candidate. The employers may be able to fill positions by offering higher wages; otherwise, they may have to settle for candidates who do not match their notion of "ideal." Under these labor market conditions, the issue becomes one of the *quality* of job candidates, not necessarily *quantity* of people willing and able to do that job. From the employers' perspective, a shortage of workers exists; from the job market perspective, the existence of a shortage could be questioned because a qualified worker filled the job.

Economists who have studied occupational shortages generally hold the view that in an unconstrained market, supply will equal demand at the "true" market price. If demand exceeds supply, salaries will be bid up until the market clears. Thus, in theory, most labor shortages should disappear as employers increase wages to attract more workers. Different types of shortages resulting from various labor market situations may, however, require very different responses from both employers and workers.

Labor shortages can result from a sudden or persistently rapid increase in demand, which outpaces the job market's capacity to supply workers. Often, this type of shortage results from an increase in demand for particular goods or services. Even though wages and the labor supply also may be increasing, a shortage may result because they cannot keep up with demand. If the supply of labor is flexible enough to adjust sufficiently, however, an increase in demand alone may not lead to a shortage.

Shortages resulting from inflexible supply, on the other hand, can occur in occupations for which demand and the level of compensation fail to attract a sufficient number of jobseekers. When years of education and specialized training are required of an occupation, a lag will continue to exist between supply and demand, even if employers increase wages. This is the case with occupations such as physicians and college or university faculty. A decrease in the supply of labor can also create a labor shortage, especially in tight labor markets where employers face keener competition for workers. If wages are higher in other occupations, workers are faced with more choices, making employment in one occupation or for one employer more or less attractive than another.

A slow reaction or response time by employers or by workers also will slow market adjustment time. It may take time for employers to recognize the difficulty of finding workers or for workers to realize the opportunities available. Also, response time may be slowed by institutional barriers, such as limited enrollment capacity in

training institutions or requirements such as licensing and certification.

Reluctance on the part of employers to raise wages often causes, or at least contributes to, a shortage. In some cases, the wage or salary level cannot increase because of a fixed compensation structure within an organization. Employers may also be reluctant to raise wages or salaries because the company places a higher priority on avoiding increases in costs. If wages are increased to attract new employees, the employers may then have to increase the wages of workers already on their payrolls to avoid dissension among longer tenured, more experienced employees.

Besides increasing wages, employers can respond in a number of other ways when faced with the difficulty of filling vacancies, but generally try the least expensive response first. One reaction to a perceived shortage involves an increase in recruiting efforts. This can be accomplished by stepping up advertising campaigns and by expanding the recruiting area, which could involve greater use of employment agencies, rewarding existing employees who bring in new workers, or offering bonuses to new hires for joining the firm.

Employers may handle staffing shortages by increasing the use of overtime, restructuring the workforce, or using workers from one occupation to perform the tasks of another occupation. To illustrate: in response to a shortage of registered nurses in the late 1980s, hospitals asked existing staff to work more overtime and restructured the work to make more use of nursing aides, licensed practical nurses, and other hospital workers.

Employers who have difficulty filling vacancies may also relax or reduce the minimum qualifications for the job or expand worker training, or both (in many cases, the two go hand-in-hand). After relaxing the hiring specifications, employers may find that the work can be completed by conducting additional training to bring less qualified workers up to speed. This may involve providing financial assistance to persons still in school, with the stipulation that they will stay with the firm for a specified time once the training is completed.

No single empirical measure of occupational shortages exists, nor does it appear that one can easily be developed. Data available through the Nation's statistical programs, however, can be used to observe some aspects of supply and demand and assess job market conditions. Research on shortages indicates that available data on employment, unemployment rates, and wages can be evaluated to assess the existence of or potential for a shortage.[63]

By looking at "snapshots" of the labor market over time, it is possible to evaluate changes in demand and supply for a particular occupation. For example, dramatic growth in employment in a particular occupation over a period of time likely reflects a significant rise in demand for that type of worker. Likewise, an uncharacteristically low unemployment rate for a specific occupation may imply the demand of workers exceeds supply. Rapidly rising relative wages in a particular occupation also could be associated with a level of demand that exceeds supply.

Assessing supply and demand in a specific occupation also requires analysis of factors such as educational qualifications, training, and entry requirements. Clearly, job market conditions for occupations such as physician and registered nurse, which require specific academic training and a license, must be analyzed differently than for fast food preparation and service workers, jobs that are often filled by high school students. Data on academic completions collected by the U.S. Department of Education, for example, provide information on the supply of graduates by field of study and level of degree for any given year.

Most research studies emphasize the importance of considering multiple measures of labor market conditions and tracking them over time to determine whether conditions of a shortage exist. Available data should be combined with background information on the occupation and knowledge of the workings of the labor market. Information on supply such as data on demographic characteristics, educational completions by field of study, and employer education and training requirements plays a significant role in completing an analysis of the labor market in an occupation.

As indicated earlier in this chapter, the United States has enjoyed over 7 years of economic expansion, during which the national unemployment rate dropped from 7.5 percent in 1992 to 4.5 percent in 1998, the lowest level since 1969. As the labor market tightened over this period, shortages in certain occupations were widely reported in the media, led by stories of unmet needs for workers skilled in information technology. Groups such as the Information Technology Association of America and the U.S. Department of Commerce's Office of Technology Policy identified what they considered "substantial evidence that the United States is having trouble keeping up with the demand for new information technology workers."[64] Shortages also were reported for construction laborers and craft workers. According to the National Center for Construction Education and

Research, "Sixty-five percent of the contractors responding to its third annual survey in 1997 reported shortages in one or more crafts."[65] Related stories in papers across the country proclaimed the resurgence of a shortfall of registered nurses, a need for qualified teachers, and even shortages of workers such as roustabouts and nannies.

At this time, no specific sources of data exist that provide a measure of occupational shortages. In the absence of any definitive measure, analysts generally rely on labor market data to corroborate anecdotal reports of employers' difficulties in filling jobs. Labor market data, combined with background information on a specified occupation, anecdotal evidence, and factors of demand and supply work in combination to assess occupational shortages.

Conclusion

When change occurs in the production of goods and services both workers and employers must adapt. The types of jobs employers need are dictated in large part by changing consumer demands and international trade, but also by changes in technology, which evoke a restructuring of the nature of work. Workers have responded by acquiring the skills needed through education and job training. Changing family relationships have led women to enter the labor market in increasing numbers. Those workers who have gained skills that are in demand have been increasingly well rewarded. This chapter documents many of these effects.

Skills are, of course, multidimensional. Furthermore, some dimensions of skill are quite difficult to measure. This chapter therefore adopts the pragmatic approach of measuring skills in different ways. At times, schooling and work experience levels have been used as a proxy for skill. At other points, wage rates themselves have been used to measure skill. The main emphasis has been, however, on occupation as a summary indicator of skill.

The most fundamental finding is that skills are rewarded. It is abundantly clear that greater schooling and training tend to lead to higher wage rates. It is also clear that there are substantial differences in job duties and wage rates, both across occupations and within occupations. Occupations have specific competency profiles, and competency pays. This appears to be particularly true for competencies or abilities that might be broadly considered cognitive in nature. The ability to do complex work or manage effectively is also highly valued. Differences in competencies have resulted in wage dispersion within occupations.

By most of our measures, the skill levels of the American workforce have increased substantially in the recent past. This is most apparent in increased schooling levels. It is also apparent in occupational shifts. Most employment growth is in occupations not requiring a postsecondary degree—a set of occupations that spans a large fraction of the jobs in the American labor market—but occupations with higher schooling requirements are growing faster than average. Consequently, employment has shifted toward occupations requiring more education and training.

These occupational shifts are reflected in occupational upskilling, meaning shifts in employment toward jobs that tend to pay higher wages. Conceptually such upskilling can occur through shifts in the industrial structure, or through shifts in occupational composition within industries. The relative importance of these avenues of occupational upskilling differ among industrial categories, at least in the labor market of the 1990s. The primary contributor to the increase in skills is occupational upgrading within industries. Shifts in industrial composition account for a small portion of the overall increase in skill change. In addition, most of the change is due to the growing service-producing industries.

There is no guarantee that the forces causing changes in the recent past will persist into the near future. The value and need for skills will, therefore, likely change in unpredictable ways. "Although employers will continue to require workers at all levels of education and training, those with the most education or work experience usually will have more options in the job market and better prospects for obtaining the higher-paying jobs."[66]

Table 2-1. **Employment shifts among occupational groups averaged over detailed industries sorted by change in share. 1989-97**

Industry and occupation	Wage-weighted employment[1]			
	Percent share in 1989	Percent share in 1997	Change in share	1997 mean wage
All industries				
Professional	24.4	29.0	4.6	$19.01
Sales workers	10.1	10.7	0.6	15.07
Production II[2]	14.7	12.9	- 1.8	10.33
Agricultural	0.4	0.5	.1	9.59
Production I[3]	12.9	11.2	- 1.7	13.84
Service occupations	7.8	8.9	1.1	9.25
Managerial	14.7	13.6	- 1.1	26.96
Clerical	15.0	13.3	- 1.7	10.93
Goods-producing sector				
Production II[2]	30.4	30.7	.3	11.47
Production I[3]	25.5	27.7	2.2	15.34
Agricultural	.3	.7	.4	11.66
Sales workers	3.6	3.7	.1	20.55
Service occupations	.9	.7	- .2	10.20
Professional	16.6	15.1	- 1.5	19.99
Managerial	14.0	13.7	- .3	29.91
Clerical	8.7	7.6	- 1.1	11.94
Service-producing sector				
Professional	28.0	33.6	5.6	18.68
Sales	13.1	13.0	- .1	13.25
Production I[3]	7.1	5.7	- 1.4	13.34
Agricultural	.4	.4	([4])	9.04
Service occupations	11.0	11.6	.6	8.93
Production II[2]	7.4	7.0	- .4	9.95
Managerial	14.9	13.5	- 1.4	25.97
Clerical	18.0	15.2	- 2.8	10.59

[1] Calculated by multiplying the total industry employment of each occupation by its wage rate.
[2] Includes machine setters, set-up operators, operators, and tenders; hand working production occupations; plant and system occupations; transportation and material moving machine and vehicle operators; and helpers, laborers, and material movers, hand.
[3] Includes production supervisors; inspectors; mechanics, installers, and repairers; construction trades and extractive occupations; and precision production occupations.
[4] Indicates value is less than 0.05 percent and greater than -0.05 percent.

SOURCE: Tabulations from the Occupational Employment Statistics Survey 1989-97, Bureau of Labor Statistics, U.S. Department of Labor

Table 2-2. **Index of skill change within occupational groups, 1989-97**

Industry sector	Skill index						
	Managerial	Professional	Clerical	Sales	Service	Production I[1]	Production II[2]
All industries	- 0.4	0.7	0.3	0.8	- 0.8	0.6	([3])
Goods-producing sector:	.4	- .1	.6	- 1.0	- 2.1	.8	([3])
Mining and Construction	.7	- 1.0	1.1	- .6	- .1	.7	- 0.8
Manufacturing	.3	.2	.5	- 1.1	- 2.8	.9	.2
Service-producing sector:	- .7	1.0	.2	1.4	- .3	.5	([4])
Transportation, communications, public utilities	- .6	- .4	- .3	- .1	- 1.6	.2	([4])
Trade	.4	.2	.4	.3	1.2	2.2	([4])
Finance, insurance, and real estate	([3])	- .1	.7	- .7	- .5	2.5	([4])
Services	- 1.5	1.9	.1	2.7	- .8	- .6	([4])

[1] Includes production supervisors; inspectors; mechanics, installers, and repairers; construction trades and extractive occupations; and precision production occupations.

[2] Includes machine setters, set-up operators, operators, and tenders; hand working production occupations; plant and system occupations; transportation and material moving machine and vehicle operators; and helpers, laborers, and material movers, hand.

[3] Indicates value is less than 0.05 percent and greater than -0.05 percent.

[4] Data do not meet publication standards.

SOURCE: Tabulations from the Occupational Employment Statistics Survey 1989-97, Bureau of Labor Statistics, U.S. Department of Labor.

Table 2-3. **Employment shifts among clerical, service, and production I[1] occupations within detailed industries averaged across all industries, 1989-97**

Occupational group	Wage-weighted employment[2]			1997 mean wage
	Percent share in 1989	Percent share in 1997	Change in share	
Clerical				
Industry-specific clerical	8.5	10.7	2.2	$10.74
Material recording, scheduling, dispatching, and distributing	14.6	14.7	0.1	10.74
First line clerical supervisors	9.1	10.9	1.8	15.62
Other clerical occupations	2.6	2.9	.3	11.14
Communications equipment operators and mail clerks	1.9	1.7	- .2	9.12
Data-processing and other office machine operators	4.2	3.4	- .8	10.79
Secretaries	59.1	55.8	- 3.3	10.66
Service				
Service supervisors	11.3	9.1	- 2.2	15.00
Protective service	15.6	13.7	- 1.9	10.14
Food and beverage preparation and service	14.9	15.0	.1	8.11
Health services and related	7.0	10.6	3.6	8.92
Cleaning and building service	42.6	41.5	- 1.1	8.39
Personal service	3.2	4.0	.8	7.96
Other service occupations	5.5	6.0	.5	9.70
Production I[1]				
Production, construction, maintenance supervisors	19.0	21.1	2.1	17.77
Inspectors and related	5.6	5.2	- .4	12.42
Mechanics, installers, and repairers	46.3	48.2	1.9	13.01
Construction trades and extractive occupations	14.8	14.7	-.1	14.68
Precision production occupations	14.4	10.8	- 3.6	13.10

[1] Includes the occupational groups listed in the table above and excludes machine setters, set-up operators, operators, and tenders; hand working production occupations; plant and system occupations; transportation and material moving machine and vehicle operators; and helpers, laborers, and material movers, hand, which are aggregated under production II.

[2] Calculated by multiplying the total industry employment of each occupation by its wage rate.

SOURCE: Tabulations from the Occupational Employment Statistics Survey 1989-97, Bureau of Labor Statistics, U.S. Department of Labor

Table 2-4. **Percent distribution of workers in selected occupations by level,[1] 1996**

Occupation	Level							
	I	II	III	IV	V	VI	VII	VIII
Professional								
Accountant	9.1	31.5	36.7	17.9	4.3	0.6	-	-
Accountant-public	20.2	30.3	33.6	15.9	-	-	-	-
Attorneys	9.2	21.9	30.4	25.2	10.9	2.3		
Engineers	4.8	12.3	26.3	29.1	18.7	7.0	1.6	0.2
Administrative								
Budget analysts	6.3	27.4	41.2	25.1	-	-	-	-
Buyer/contracting specialist	14.9	44.2	31.1	9.8	-	-	-	-
Computer programmers	6.9	30.9	38.2	17.3	6.8	-	-	-
Computer systems analysts	17.1	45.5	29.2	7.4	.8	-	-	-
Computer systems supervisors/managers	46.6	43.0	10.4	-	-	-	-	-
Personnel specialists	3.4	27.3	37.9	24.0	6.5	.8	-	-
Personnel supervisors/ managers	35.0	40.1	20.2	4.7	-	-	-	-
Tax collectors	13.5	46.7	39.8	-	-	-	-	-
Technical								
Computer operators	6.4	49.7	35.9	7.4	.6	-	-	-
Drafters	11.4	34.6	36.3	17.7	-	-	-	-
Engineering technicians	2.9	12.5	26.8	33.2	19.8	4.8	-	-
Engineering technicians/civil	9.0	17.5	35.2	27.7	9.2	1.4	-	-
Protective service								
Police officers	96.6	3.4	-	-	-	-	-	-
Clerical								
Clerks, accounting	3.1	49.0	38.4	9.6	-	-	-	-
Clerks, general	3.6	30.8	43.7	21.9	-	-	-	-
Clerks, order	70.3	29.7	-	-	-	-	-	-
Key entry operators	63.3	36.7	-	-	-	-	-	-
Personnel assistants	7.8	39.6	41.0	11.6	-	-	-	-
Secretaries	16.8	31.7	34.5	14.3	2.7	-	-	-
Word processors	31.0	57.0	12.0	-	-	-	-	-
Maintenance and toolroom								
Maintenance electronic technicians	9.6	75.4	14.9	-	-	-	-	-
Material movement and custodial								
Guards	87.6	12.4	-	-	-	-	-	-
Truckdrivers[2]	11.1	26.2	26.3	36.4	-	-	-	-

[1] Occupations included in Occupational Compensation Survey pre-set job list.

[2] Data were compiled for four different truckdriver occupations—Light, medium, heavy, and tractor-trailer. For this illustration, these truckdriver occupations were classified as levels I, II, III, and IV, respectively, because the job duties and skills required increased for each job level.

NOTE: Dashes indicate that the level was not applicable to the occupation.

SOURCE: *Occupational Compensation Survey: National Summary, 1996*, Bulletin 2497, March 1998, Bureau of Labor Statistics, U.S. Department of Labor

Table 2-5. **Mean weekly and hourly earnings by level for selected occupations,[1] 1996**

Occupation	Level							
	I	II	III	IV	V	VI	VII	VIII
Weekly earnings								
Professional								
Accountant	$523	$626	$811	$1,041	$1,375	$1,734	-	-
Accountant-public	594	641	747	977	-	-	-	-
Attorneys	700	952	1,260	1,647	1,994	2,415	-	-
Engineers	675	805	959	1,167	1,411	1,659	$1,962	$2,343
Administrative								
Budget analysts	585	667	858	964	-	-	-	-
Buyer/contracting specialist	522	662	889	1,085	-	-	-	-
Computer programmers	543	639	788	945	1,095	-	-	-
Computer systems analysts	779	940	1,111	1,321	1,527	-	-	-
Computer systems supervisors/ managers	1,202	1,408	1,665	-	-	-	-	-
Personnel specialists	515	611	804	1,045	1,362	1,784	-	-
Personnel supervisors/managers	1,160	1,460	1,788	2,253	-	-	-	-
Tax collectors	513	588	771	-	-	-	-	-
Technical								
Computer operators	357	448	576	689	820	-	-	-
Drafters	408	504	640	816	-	-	-	-
Engineering technicians	390	518	650	781	898	1,070	-	-
Engineering technicians-civil	356	489	593	730	865	1,081	-	-
Protective service								
Police officers	770	930	-	-	-	-	-	-
Clerical								
Clerks, accounting	320	379	464	549	-	-	-	-
Clerks, general	289	342	429	493	-	-	-	-
Clerks, order	345	477	-	-	-	-	-	-
Key entry operators	353	414	-	-	-	-	-	-
Personnel assistants	332	409	508	596	-	-	-	-
Secretaries	385	476	557	665	809	-	-	-
Word processors	389	496	610	-	-	-	-	-
Hourly earnings								
Maintenance and toolroom								
Maintenance electronic technicians	11.89	18.14	20.56	-	-	-	-	-
Material movement and custodial								
Guards	7.11	12.14	-	-	-	-	-	-
Truckdrivers[2]	8.53	14.81	13.38	14.24	-	-	-	-

[1] See footnote 1, table 2-4.
[2] See footnote 2, table 2-4.

NOTE: Dashes indicate that the level was not applicable to the occupation.

SOURCE: *Occupational Compensation Survey: National Summary, 1996*, Bulletin 2497, March 1996, Bureau of Labor Statistics, U.S. Department of Labor

Table 2-6. **Modal values of selected generic leveling factors by major occupational group, 1998**

Major occupational group	Knowledge (Scale:1-9)	Supervision received (Scale:1-5)	Guidelines (Scale:1-5)
Professional	6	3	3
Technical	4	3	2
Executive	6	3	3
Sales	2	2	1
Clerical	3	2	2
Precision production	4	3	3
Machine operatives	2	2	1
Transport	2	2	2
Laborers	1	1	1
Service	2	1	1

SOURCE: Tabulations from the 1998 National Compensation Survey, Bureau of Labor Statistics, U.S. Department of Labor

Table 2-7. **Average hourly wage rates by knowledge level, 1998**

Major occupational group	Knowledge level								
	1	2	3	4	5	6	7	8	9
All	$6.68	$8.88	$11.96	$16.12	$18.61	$23.06	$31.15	$46.08	$53.68
Professional	-	-	-	12.39	18.04	23.59	29.76	42.03	-
Technical	-	8.85	11.16	14.60	17.91	23.79	-	-	-
Executive	-	-	-	13.42	15.71	20.69	31.32	49.26	-
Sales	6.30	7.74	10.16	14.62	-	-	-	-	-
Clerical	6.84	9.02	11.58	15.05	16.24	-	-	-	-
Precision production	-	9.36	13.65	18.07	21.89	25.35	-	-	-
Machine operatives	7.37	10.22	13.11	16.51	-	-	-	-	-
Transport	7.27	11.66	14.59	18.17	-	-	-	-	-
Laborers	7.13	9.75	13.33	-	-	-	-	-	-
Service	6.18	7.18	10.65	16.16	-	-	-	-	-

NOTE: Dashes indicate that the level was not applicable to the occupation.

SOURCE: Tabulations from the 1998 National Compensation Survey, Bureau of Labor Statistics, U.S. Department of Labor

Table 2-8. **Estimated wage premiums for greater job duties, 1998**[1]
(in percent)

Level	Knowledge	Supervision received	Guidelines	Complexity	Scope and effect	Personal contacts	Purpose of contacts	Physical demands	Work environment	Supervisory duties
1	-	-	-	-	-	-	-	-	-	-
2	9.5	8.8	6.5	2.6	2.6	-1.2	2.5	-2.3	3.8	1.7
3	18.7	17.1	11.5	7.8	5.4	1.6	3.3	-2.1	5.9	6.7
4	35.6	25.6	21.0	9.1	7.0	6.5	2.9	-	-	14.0
5	57.2	38.2	35.0	14.0	14.0	-	-	-	-	42.4
6	80.5	-	-	28.3	2.0	-	-	-	-	-
7	106.7	-	-	-	-	-	-	-	-	-
8	128.2	-	-	-	-	-	-	-	-	-
9	116.6	-	-	-	-	-	-	-	-	-

[1] The table presents wage differentials between jobs with the given levels of the job attribute and jobs with the lowest level of the attribute. Wage differentials are shown in percent, and are based on a wage regression that controls for other characteristics of the establishment and job.

NOTE: Dashes indicate that the level was not applicable to the occupation.

SOURCE: Regression results from the 1998 National Compensation Survey, Bureau of Labor Statistics, U.S. Department of Labor

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[28] More specifically, OPT measures changes in the skill-composition of the work force between years t and t–1 with the following formula:

$$\Delta \ln C_t \equiv \Delta \ln L_t - \Delta \ln H_t, \text{ where}$$

$$\Delta \ln L_t \equiv \tilde{\alpha}_{1,t} \Delta \ln H_{1,t} + \tilde{\alpha}_{2,t} \Delta \ln H_{2,t} + \cdots + \tilde{\alpha}_{L,t} \Delta \ln H_{L,t}.$$

In the second equation above, the rate of growth of hours worked by persons with the set of characteristics l at time t is $\Delta \ln H_{lt} = \ln H_{l,t} - \ln H_{l,t-1}$. The rate of growth of hours worked by all persons is $\Delta \ln H_t$.

The labor cost share weight $\tilde{\alpha}_{l,t}$ for persons with characteristics l at time t is calculated with the following formula:

$$\tilde{\alpha}_{l,t} = \frac{1}{2}\left[\left(w_{l,t} H_{l,t} \Big/ \sum\nolimits_{\forall m,t} w_{m,t} H_{m,t}\right) + \left(w_{l,t-1} H_{l,t-1} \Big/ \sum\nolimits_{\forall m,t-1} w_{m,t-1} H_{m,t-1}\right)\right], \quad l = 1 \ldots m.$$

A conventional human capital wage equation is used to estimate conditional mean wage rates $w_{l,t}$. That is, $w_{l,t} = \beta_o + \beta_{s,t} s_{t,t} + \beta_{e,t} e_{t,t} + \beta_{d,t} d_{t,t}$ The number of years of school completed in year t by persons with characteristics l is represented by $s_{t,t}$, and $e_{t,t}$ is an estimate of the number of years of actual work experience. Demographic and geographic variables are represented by $d_{t,t}$, including categorical variables for the nine Census regions, and additional categorical variables for ever-married status, Black or Hispanic ethnicity, veteran status and residence within a central city. The equations are estimated separately for males and females.

Rearranging terms, $\Delta \ln C_t \equiv \tilde{\alpha}_{,t1}\left(\Delta \ln H_{1,t} - \Delta \ln H_t\right) + \cdots + \tilde{\alpha}_{L,t}\left(\Delta \ln H_{L,t} - \Delta \ln H_t\right)$. Thus, an increase in the labor composition index reflects a faster rate of growth of hours worked by high-skilled workers, longer hours worked by high skilled workers, on average, and/or an increase in the wage rate differential between high-skilled and low-skilled workers.

[29] Production is assumed to exhibit constant returns to scale. That is, doubling all inputs produces exactly twice as much output. Although not required for productivity measurement, meaningful and unambiguous measures of labor composition require that capital is separable from labor (the combination of hours and labor composition) and, in turn, that hours are separable from labor composition. While tests for separability can be made only when production is explicitly modeled, separability exists when one input can

be measured independently of the prices and quantities of other inputs.

[30] Krueger and Summers have provided influential time series estimates of occupational and industrial wage differentials. See Alan B. Krueger and Lawrence H. Summers (1988), "Efficiency Wages and the Inter-Industry Wage Structure," *Econometrica*, Vol. 56, pp. 259-293.

[31] Some sources of wage differentials include unobserved differences in the characteristics or training of workers, compensating differentials for job risks or amenities, rent sharing of monopoly profits of firms, imbalances between the supply and demand for workers, or restrictions in the supply of workers such as unions or licensing requirements.

[32] This theoretical argument is advanced in John Pencavel (1972), "Wages, Specific Training, and Labor Turnover in U.S. Manufacturing Industries," *International Economic Review*, Vol. 13, No. 1, pp. 53-64. Empirical results that are consistent with the theoretical argument are presented in Atsushi Seike and Hong W. Tan (1994), "Labor Fixity and Labor Market Adjustments in Japan and the United States," in *Troubled Industries in the United States and Japan*, Tan and Shimada, Eds., New York: St. Martin's Press, pp. 211-233.

[33] Steven Allen (1984), "Unionized Construction Workers are More Productive," *Quarterly Journal of Economics*, Vol. 99, pp. 251-274.

[34] For sources of skill change in the 1970s and 1980s, see David R. Howell and Edward N. Wolff. (1991). "Trends in the Growth and Distribution of Skills in the U.S. Workplace, 1960-1984." *Industrial and Labor Relations Review*, Vol. 44, No. 3, April 1991.

[35] The Occupational Employment Statistics (OES) survey is an annual mail survey measuring occupational employment and occupational wage rates for wage and salary workers in nonfarm establishments, by industry. The survey samples approximately 400,000 establishments per year, taking 3 years to fully collect the sample of 1.2 million establishments. These annual surveys are part of a Federal-State cooperative program. BLS provides the procedures and technical support, while the State Employment Security Agencies (SESAs) collect the data. The SESAs produce estimates for local areas and the States. BLS produces estimates for the Nation. The OES survey sample is stratified by area, industry, and size class. States' Unemployment Insurance (UI) files provide the universe from which the OES survey draws its sample. The employment benchmarks are obtained from reports submitted by employers to the UI program. In some nonmanufacturing industries, supplemental sources are used for establishments not reporting to the UI program.

The OES survey produces data on employment, average (mean) wage, and median wage for over 750 detailed occupations in 378 detailed industry categories (at the 3-digit level of the Standard Industrial Classification). The survey also covers Federal, State, and local government establishments. The OES classification system uses seven occupational divisions to categorize workers in detailed occupations. The seven divisions are: 1) Managerial and administrative, 2) professional, paraprofessional, and technical, 3) sales and related, 4) clerical and administrative support, 5) service, 6) agriculture, forestry, fishing, and related, and 7) production, construction, operating, maintenance, and material handling.

[36] For a discussion of the conceptual framework underlying this demand measure, see Lawrence F. Katz and Kevin M. Murphy. (1992). "Changes in Relative Wages, 1963-1987: Supply and Demand Factors." *Quarterly Journal of Economics*, Vol. 107, No. 1, February, 1992.

[37] For a similar measure, see Kevin M. Murphy and Finis Welch. (1993). "Occupational Change and the Demand for Skill, 1940-1990." *American Economic Association Papers and Proceedings*, Vol. 83, No. 2, May, 1993.

[38] This decomposition is accomplished by creating a third skill index which measures skill changes for 1-digit occupational codes within detailed industries. The difference between the growth rate of this index and the alternative index (column 2) measures the skill change within broad occupational groups.

[39] The Office of Employment Projections has developed industry-occupation matrices presenting the distribution of occupational employment by industry since the mid-1960s. A time series based on these matrices was not developed until 1994, because of concerns about the comparability of matrix data over time. Because many users of occupational employment data by industry require historical employment data for a variety of analyses, a national industry-occupation matrix time series was developed that covered the 1983-95 time period. In 1996, the time series was updated to cover the 1983-96 period. In 1998, an analysis of this time series was completed to identify trends in educational requirements. The study focused on the 1986-96 period in order to be consistent with the 10-year time frame of the Bureau's most recent employment projections, 1996-2006.

[40] CPS data are used to develop occupational distribution patterns for workers in agriculture and private households, as well as to develop economy-wide estimates of self-employed and unpaid family workers by occupation. Occupational distribution patterns for the Federal Government are developed from data compiled by the Office of Personnel Management.

[41] For an explanation of the rationale underlying the development of the education and training categories, see Darrel Patrick Wash, "A New Way to Classify Occupations by Education and Training," *Occupational Outlook Quarterly*, Winter 1996-97, pp. 28-40.

[42] The OES measure of skill change for the 1989-1997 period generally confirms the OEP findings of rising skill levels in the service sector. Where there are differences in the findings they are due to the fact that the OES measure uses wage-weighted employment, while the OEP data are based on unweighted employment counts.

[43] Of the 456 detailed occupations in the historical matrix, earnings were not available for two: government chief executives and legislators and producers, directors, actors, and entertainers.

[44] The following are the 16 occupations: All other managers and administrators; all other sales and related workers; cashiers; teachers, preschool through college, except special and adult education; general office clerks; computer engineers, scientists, and systems analysts; registered nurses; janitors and cleaners, including maids and housekeeping cleaners; truckdrivers light and heavy; salespersons, retail; all other service workers; all other agriculture, forestry, fishing, and related workers; hand packers and packagers; clerical supervisors and managers; receptionists and information clerks; all other management support workers.

[45] Classic early studies of the human capital model include Jacob Mincer (1958), "Investments in Human Capital and Personal Income Distribution, *Journal of Political Economy*, Vol. 66, No. 4, pp. 281-302; Theodore W. Schultz (1963), *The Economic Value of Education*, New York: Columbia University Press; Gary Becker (1964) Human Capital, 1st edition, New York: Columbia University Press; and Jacob Mincer (1974), *Schooling, Experience and Earnings*, New York: Columbia University Press. Early contributions to related work on hedonic price indexes can be found in Zvi Griliches (Ed., 1971), *Price Indexes and Quality Changes*, Cambridge, Massachusetts: Harvard University Press; and Sherwin Rosen (1974), "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition," *Journal of Political Economy*, Vol. 82, No. 1, pp. 34-55.

[46] The procedures followed to develop these estimates are described in BLS Bulletin 2426, *Labor Composition*, cited above, chapter 2.

[47] Chinhui Juhn, Kevin M. Murphy and Brooks Pierce (1993), "Wage Inequality and the Rise in Returns to Skill," *Journal of Political Economy*, Vol. 101, No. 3, pp. 410-442.

[48] John T. Dunlop, "The Task of Contemporary Wage Theory," in *New Concepts in Wage Determination*, G.W. Taylor and F.C. Pierson, eds., New York: McGraw-Hill, 1957.

[49] There are several skill-based pay schemes that have been widely discussed in the press; but they are rather uncommon in practice, and rarely include all workers in the establishment in those firms with such plans. These compensation schemes have various different names, such as "pay for knowledge," "skill-based pay." They set wages based on a repertoire of jobs that workers can perform; that is, their knowledge and mastery of different jobs in the organization.

[50] For a discussion of point-factor pay setting schemes, see, for example, Richard Henderson, *Compensation Management and Rewarding Performance*, Reston, VA: Reston Publishing Co., 1979.

[51] For a complete description of occupations and level characteristics see appendix B in *Occupational Compensation Survey: National Summary, 1996*, Bulletin 2497 (U.S. Department of Labor, Bureau of Labor Statistics), March 1998.

[52] For a description of the National Compensation Survey see, Harriet Weinstein, "Overview of the NCS: Summer 1998," *Compensation and Working Conditions*, Summer 1998.

[53] Supervisory duties is an experimental factor, and has not been used to determine work levels in NCS data published to date.

[54] For a more detailed description of the "generic factors" see *Evaluating Your Firm's Jobs and Pay*, (U.S. Department of Labor, Bureau of Labor Statistics). Brochure

[55] The modal value is that value occurring most frequently.

[56] Table 7 can be viewed as looking at knowledge differentials, for given occupational categories. The regression methodology can be viewed as looking at knowledge differentials for given occupational categories and other control variables. In the regression the natural logarithm of the hourly wage rate is regressed on controls for the generic leveling factors, detailed industry and occupation, survey area, full-time status, incen-

tive pay, union coverage, private or public sector employment, and establishment size.

[57] More precisely, 1.187/1.095=1.084 implies an 8.4 percent differential.

[58] Studies of specific occupations may yield different results. For example, physical risk may be important for police officers.

[59] See Carolyn Veneri (1999), "Can Occupational Labor Shortages Be Identified Using Available Data?" *Monthly Labor Review*, March, pp.15-21.

[60] Rick Melchionno and Michael Steinman, "The 1996-2006 Job Outlook in Brief," *Occupational Outlook Quarterly*, Spring 1998, p. 3.

[61] 1996-2006 employment projections were released in November 1997-see the November 1997 *Monthly Labor Review*. 1998-2008 projections will be released in November 1999.

[62] Job vacancy data by occupation would be an obvious input to analyses of occupational shortages. However, comprehensive occupational vacancy data do not exist. Although trade associations sometimes sponsor surveys of job vacancies, national data are not currently collected by any government agency. The Bureau of Labor Statistics has conducted pilot studies on occupational job vacancies and is reinstituting a Job Openings Labor Turnover Survey that will provide a broad measure of job vacancies, but not by occupation. It is important to keep in mind, however, that the simple fact that employers have vacancies does not mean a shortage exists. Trends in vacancy data would need to be evaluated along with other labor market indicators in order to understand the labor market for a particular occupation. See Lois Plunkert. Job Openings Pilot Program: Final Report, Washington: U.S. Department of Labor, Bureau of Labor Statistics, 1981. Also see Employee Turnover and Job Openings Survey: *Results of a Pilot Study on the Feasibility of Collecting Measures of Imbalances of Supply and Demand for Labor in an Establishment Survey* (1991), Washington: U.S. Department of Labor, Bureau of Labor Statistics.

[63] Studies used data in this way include Cohen and Trutko, Barnow, Chasanov, and Pande.

[64] *America's New Deficit: The Shortage of Information Technology Workers* (U.S. Department of Commerce, Office of Technology Policy), p.3.

[65] "Labor Woes: You Know How Bad It Is," Rural Builder, May 1998, p.26.

[66] George T. Silvestri (1997), "Employment Outlook: 1996-2006, Occupational Employment Projections to 2006," *Monthly Labor Review*, November, p. 62.